AHRQ Training Webinar on the Clinical Decision Support Authoring Tool

Presented by:
Sharon Sebastian, CDS Connect Project Lead, MITRE
Chris Moesel, CDS Connect Technical Lead, MITRE

Moderated by:
Edwin Lomotan, MD
Agency for Healthcare Research and Quality

February 7, 2019

Agenda

- Welcome and Introductions
- Presentations
- CDS Authoring Tool Demonstration
- Q&A Session With Presenters

Note: After today's webinar, a copy of the slides will be emailed to all participants.

Presenters and Moderator

Sharon Sebastian RN-BC, MS

- Principal Clinical Informaticist, MITRE
- CDS Connect Project Lead

Chris Moesel

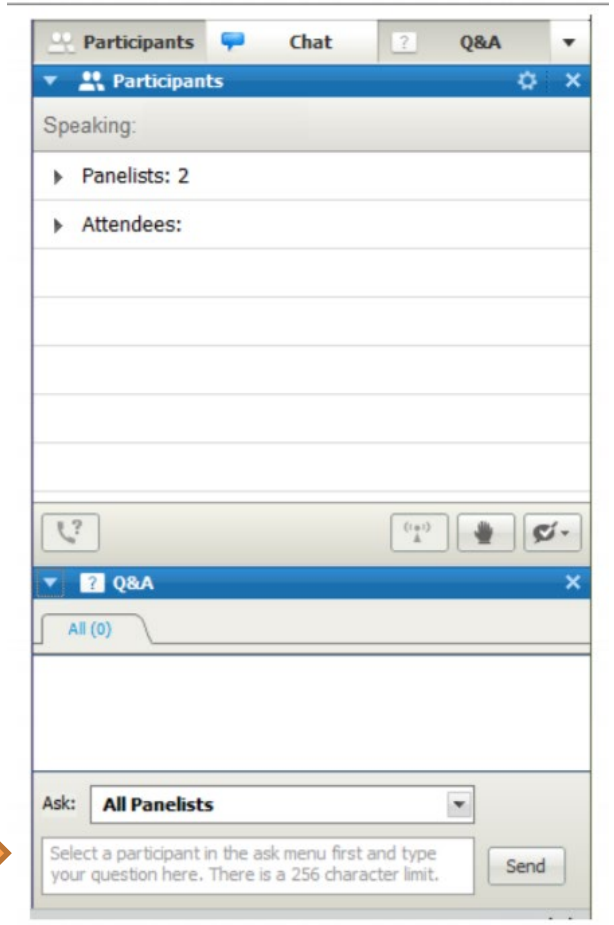
- Principal Software Systems Engineer, MITRE
- CDS Connect Technical Lead
- CDS Authoring Tool Lead

Ed Lomotan, MD

- Medical Officer
- Chief of Clinical Informatics, Center for Evidence and Practice Improvement, AHRQ

How to Submit a Question

- At any time during the presentation, type your question into the “Q&A” section of your WebEx Q&A panel.
- Please address your questions to “All Panelists” in the drop-down menu.
- Select “Send” to submit your question to the moderator.
- Questions will be read aloud by the moderator.



Learning Objectives

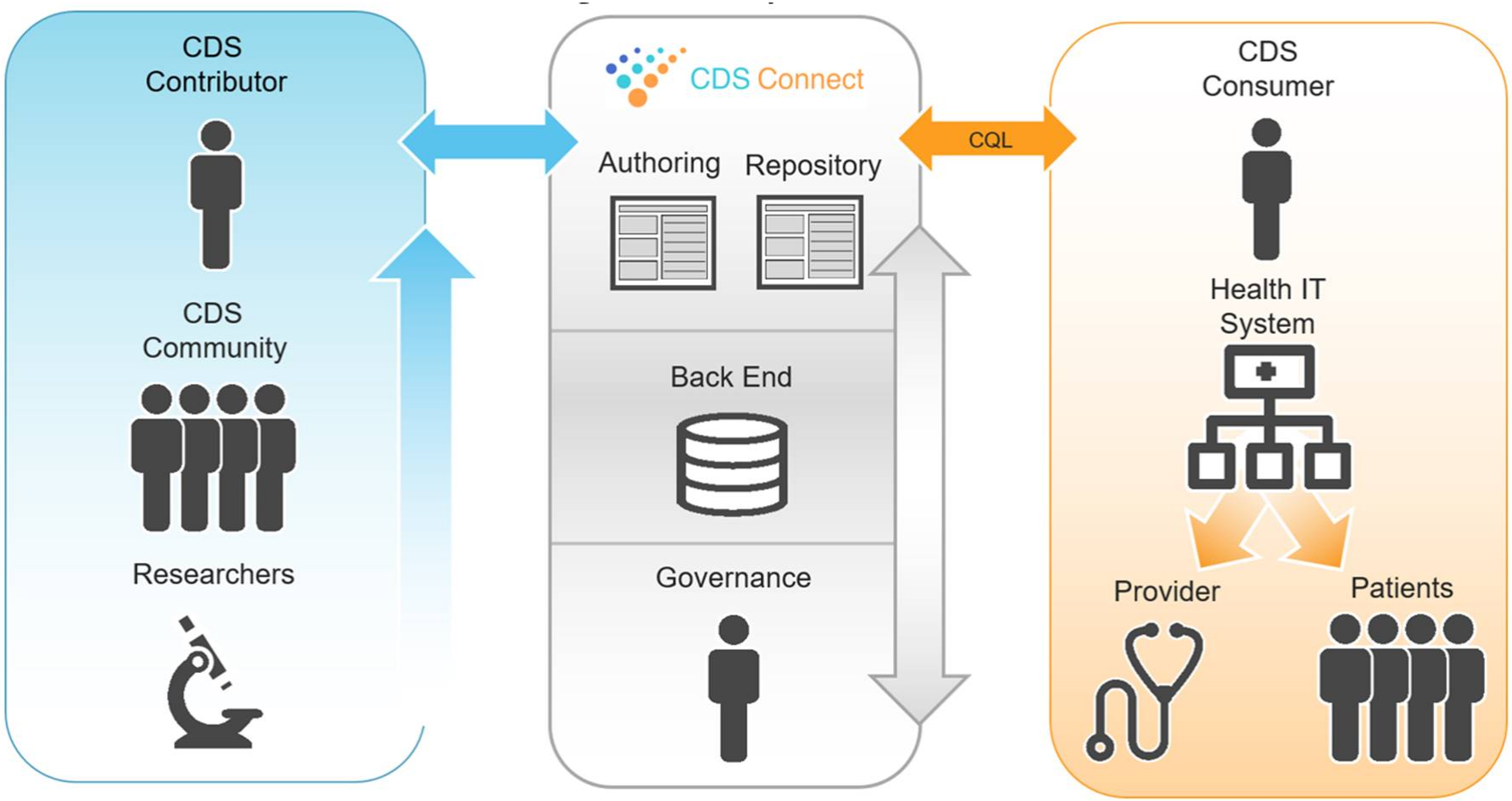
At the conclusion of this activity, participants should be able to:

1. Develop logic, including inclusion and exclusion statements, and define the recommended intervention.
2. Discuss how to develop “base elements” that can be re-used across logic statements, along with features that enable users to develop subpopulations and how to handle errors.
3. Use synthetic test data to verify that authored CDS logic works as expected.
4. Save and download their logic expression and provide an understanding of the components of the downloaded zip file.
5. Understand how other systems and tools developed by the CDS Connect project (i.e., the Repository and CQL Services) can be used to share and implement the logic developed within the Authoring Tool.

CDS Connect Project Overview and Knowledge Translation Resources

Sharon Sebastian, MITRE

CDS Connect Concept of Operations



CDS Connect Work Streams

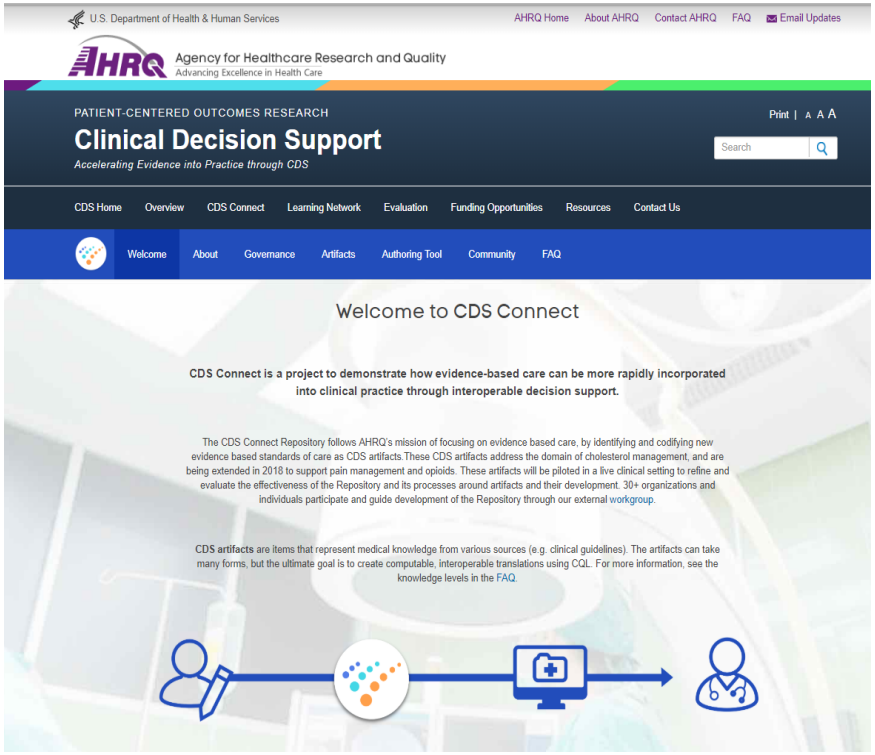
Repository: Design and build an online software "repository" for hosting and sharing new CDS artifacts

Authoring: Build a public-facing, web-based CDS Authoring Tool geared toward non-technical users

Artifacts: Identify and codify new CDS artifacts for care, in specific domains

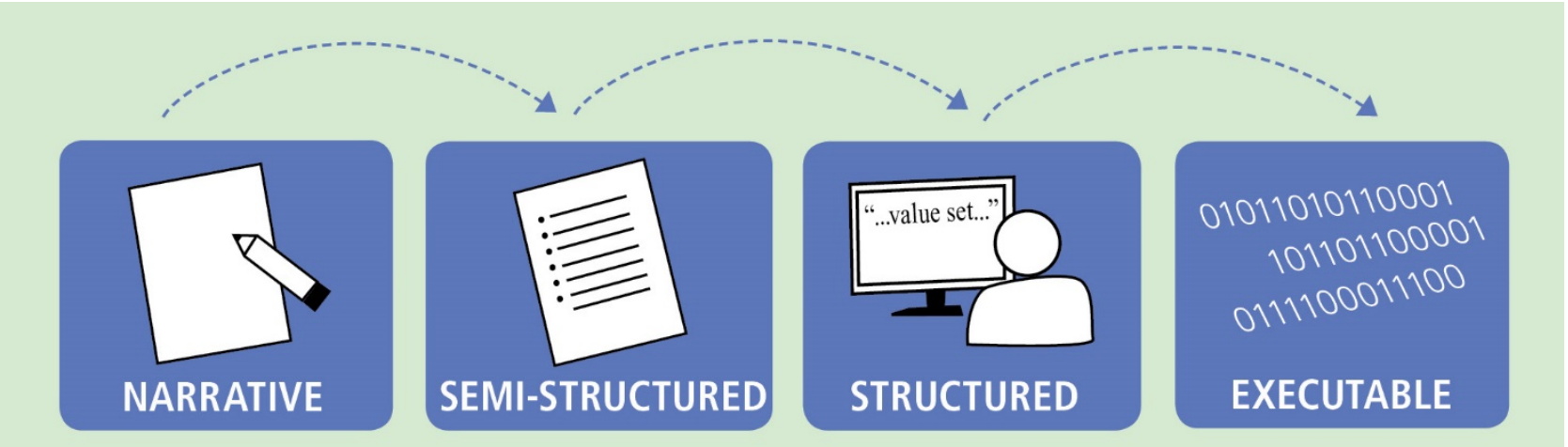
Pilot: Pilot CDS artifacts in a live, clinical setting

Work Groups: Convene external discussions focused on accelerating evidence into practice through CDS



https://cds.ahrq.gov/cdsconnect

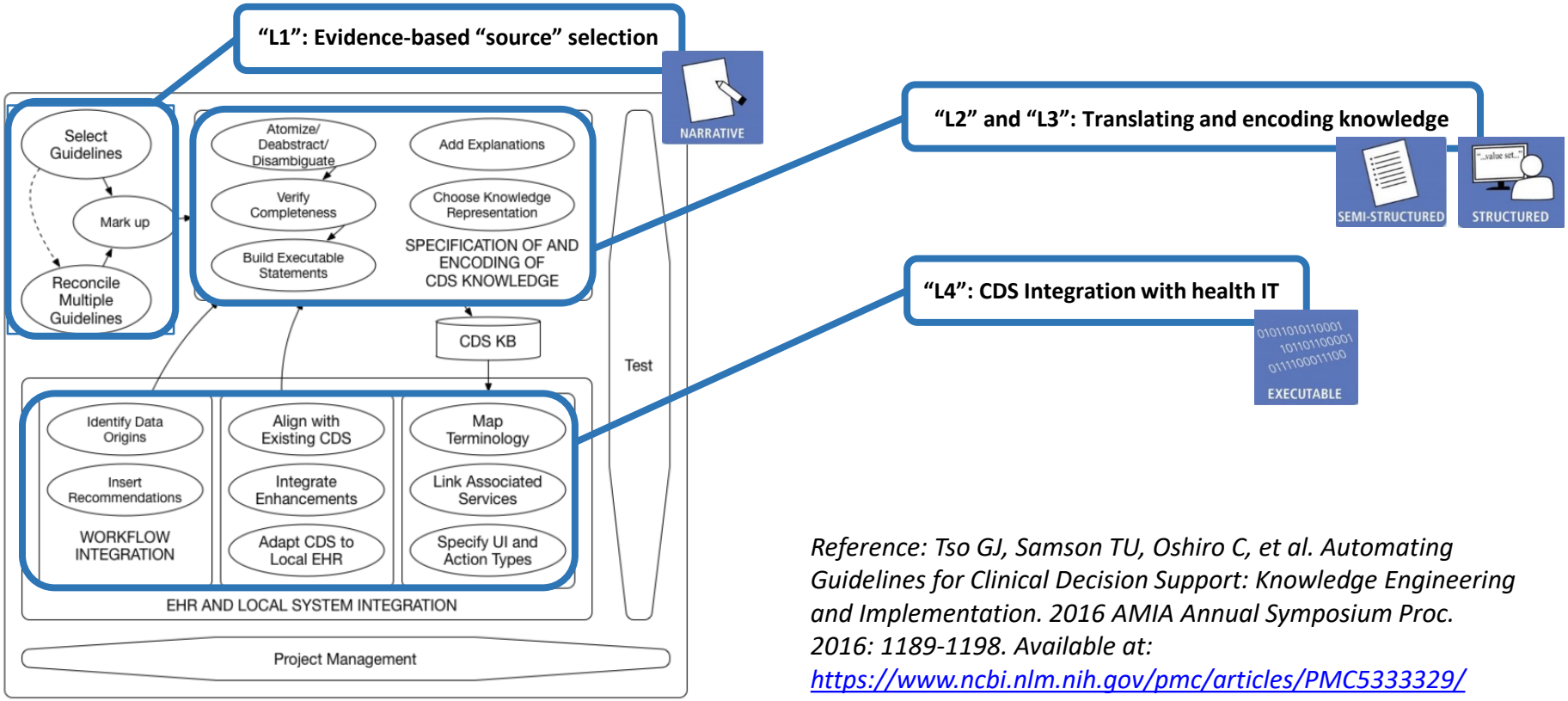
Knowledge Translation into CDS



Level 1 (or "L1") Level 2 (or "L2") Level 3 (or "L3") Level 4 (or "L4")

Adapted from: Boxwala, A. A., et al. (2011). "A multi-layered framework for disseminating knowledge for computer-based decision support." Journal of the American Medical Informatics Association : JAMIA 18 Suppl 1: i132-139.

Knowledge Translation Methodology



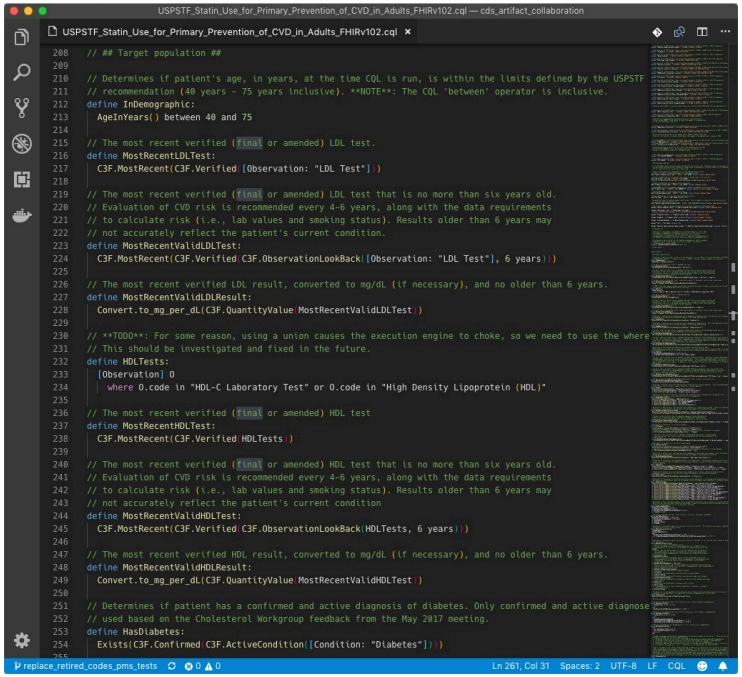
Reference: Tso GJ, Samson TU, Oshiro C, et al. Automating Guidelines for Clinical Decision Support: Knowledge Engineering and Implementation. 2016 AMIA Annual Symposium Proc. 2016: 1189-1198. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5333329/

CDS Authoring Tool Standards

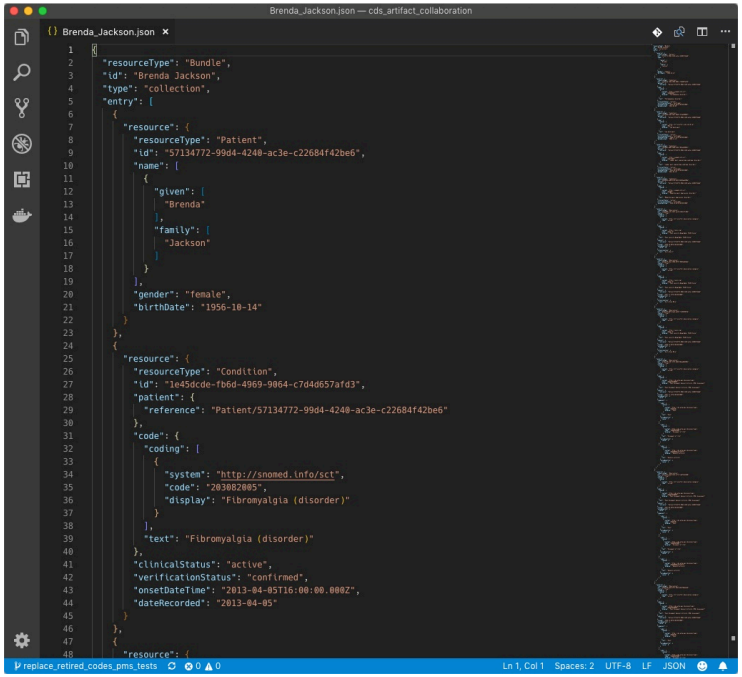
Chris Moesel, MITRE

CDS Authoring Tool: Health IT Standards

HL7 Clinical Quality Language (CQL)



HL7 Fast Healthcare Interoperability Resources (FHIR)

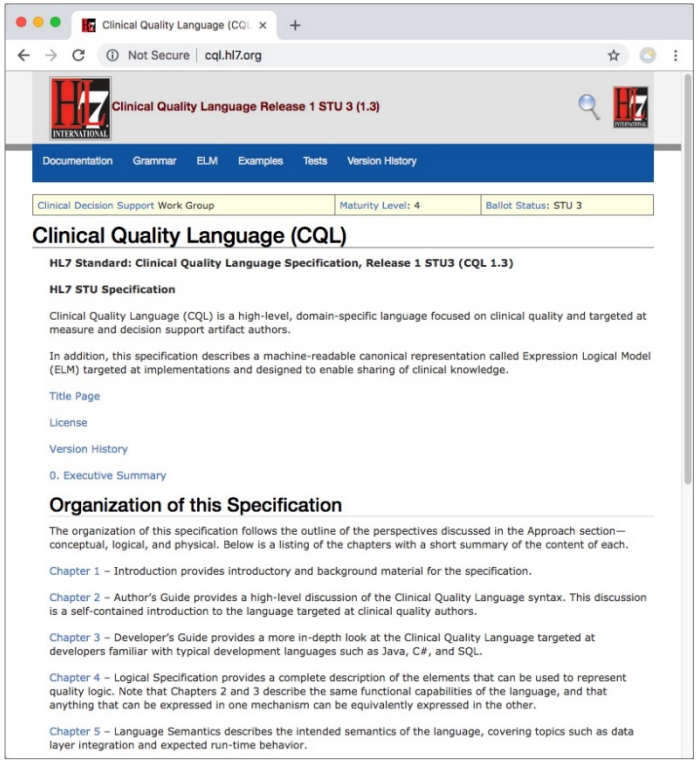


HL7 = Health Level 7

HL7 Clinical Quality Language (CQL)

"Clinical Quality Language (CQL) is a high-level, domain-specific language focused on clinical quality and targeted at measure and decision support artifact authors."

HL7 Standard: Clinical Quality Language Specification, Release 1 STU3 (CQL 1.3)
http://cql.hl7.org/



CQL Key Points

- The CQL specification defines two components:
  - **Clinical Quality Language**: Author-friendly domain-specific language
  - **Expression Logical Model**: Computable XML or JSON
- CQL leverages best practices and lessons learned from:
  - **Quality Data Model:** Focus on ease of authoring
  - **Health eDecisions:** Focus on modularity and computability
  - **eCQM & CDS Communities:** HL7 Work Groups, S&I Framework
- CQL is designed to work with any data model
- CQL is a HL7 Standard for Trial Use (STU)

CQL Example: Systolic Blood Pressure

```
valueset "Systolic Blood Pressure": '2.16.840.1.113883.3.526.3.1032'

define LastSystolicBPValue:
  Last (
    [Observation: "Systolic Blood Pressure"] O
      where O.status.value = 'final'
      and (
        O.valueQuantity.unit.value in {'mm[Hg]', 'mmHg', 'mm Hg'}
        or O.valueQuantity.code.value = 'mm[Hg]'
      )
      return FHIRHelpers.ToDecimal(O.valueQuantity.value)
      sort by O.effectiveDateTime
  )
```

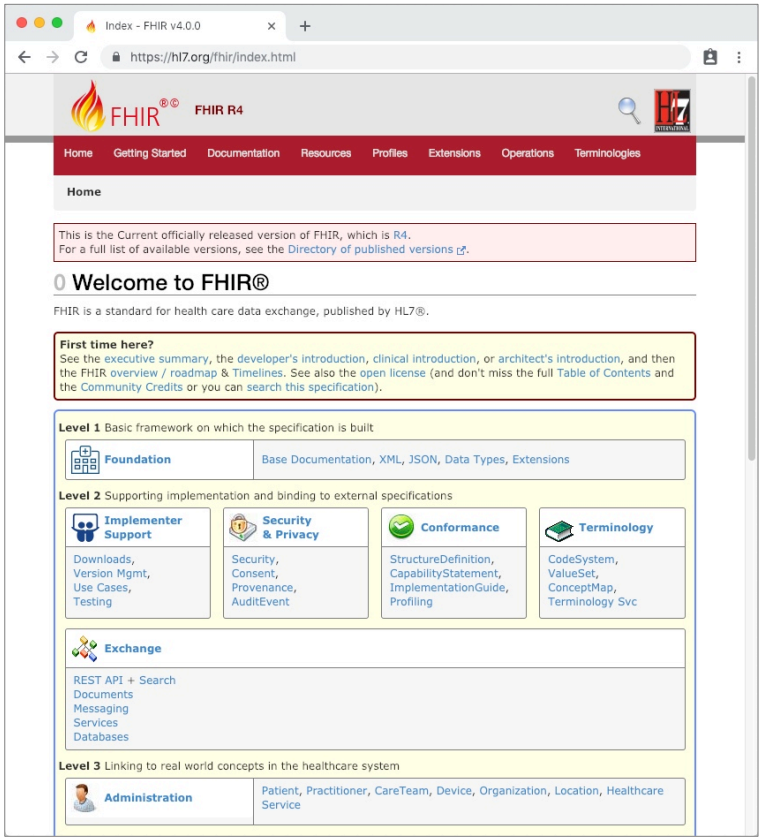
CQL Example: MeetsInclusionCriteria

```
define InDemographic:
  AgeInYears() between 40 and 75

define HasCVDRiskFactors:
  MostRecentValidLDLResult > 130 'mg/dL'
  or MostRecentValidHDLResult < 40 'mg/dL'
  or HasDiabetes
  or HasHypertension
  or IsSmoker

define MeetsInclusionCriteria:
  InDemographic
  and HasCVDRiskFactors
  and (
    MostRecentValidCVDRiskAssessmentResult >  10.0 '%'
    or (GradeCRecommendationEnabled and MostRecentValidCVDRiskAssessmentResult >= 7.5 '%')
  )
```

HL7 Fast Healthcare Interoperability Resources (FHIR)

"FHIR is a standard for health care data exchange, published by HL7®."

HL7 FHIR Release 4 (v4.0.0)
http://hl7.org/fhir/R4/index.html



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FHIR Examples: Patient and Condition

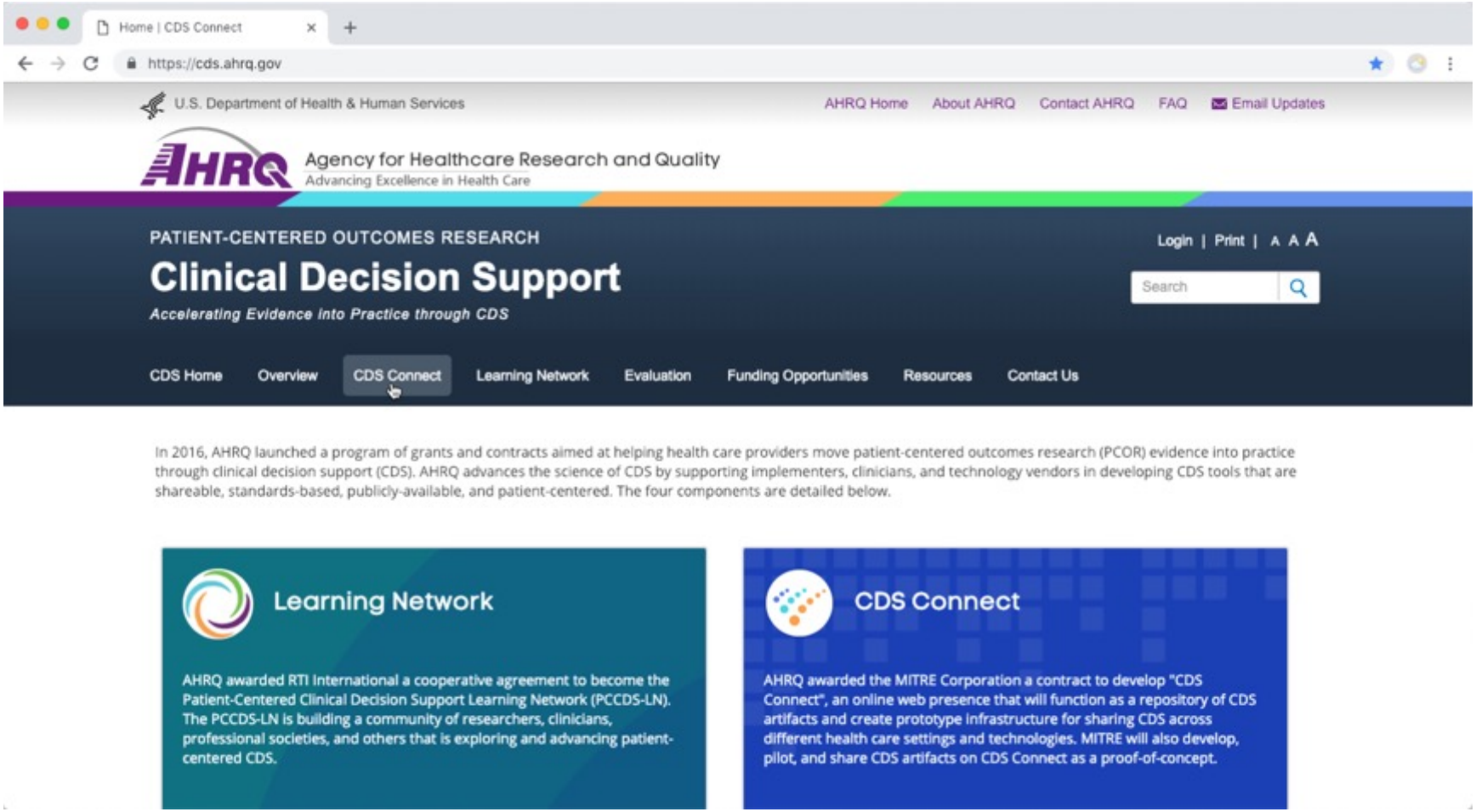
Agency for Healthcare Research and Quality


```
{
  "resourceType": "Patient",
  "id": "e7c7c18c 06e1 4426 be5b 494f4573b457",
  "name": [
    {
      "given": [
        "Brenda"
      ],
      "family": [
        "Jackson"
      ]
    }
  ],
  "gender": "female",
  "birthDate": "1956 10 14"
}
```

```
{
  "resourceType": "Condition",
  "id": "7d0735e7 f062 45af 843c a3e3e7f48888",
  "patient": {
    "reference": "Patient/e7c7c18c 06e1 4426 be5b
494f4573b457"
  },
  "code": {
    "coding": [
      {
        "system": "http://snomed.info/sct",
        "code": "203082005",
        "display": "Fibromyalgia (disorder)"
      }
    ],
    "text": "Fibromyalgia (disorder)"
  },
  "clinicalStatus": "active",
  "verificationStatus": "confirmed",
  "onsetDateTime": "2013 04 05T16:00:00.000Z",
  "dateRecorded": "2013 04 05"
}
```

CDS Connect Repository

CDS Connect Repository



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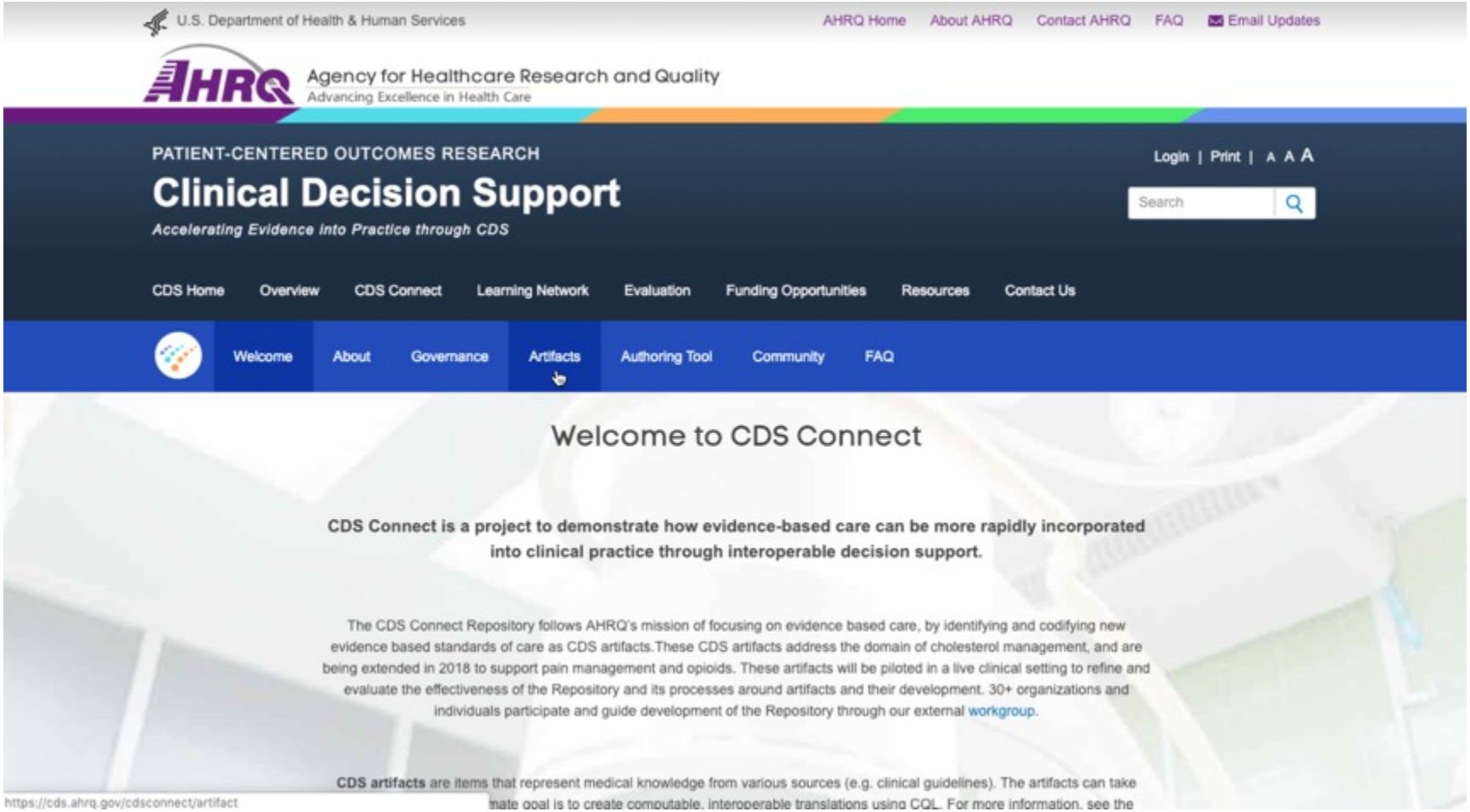

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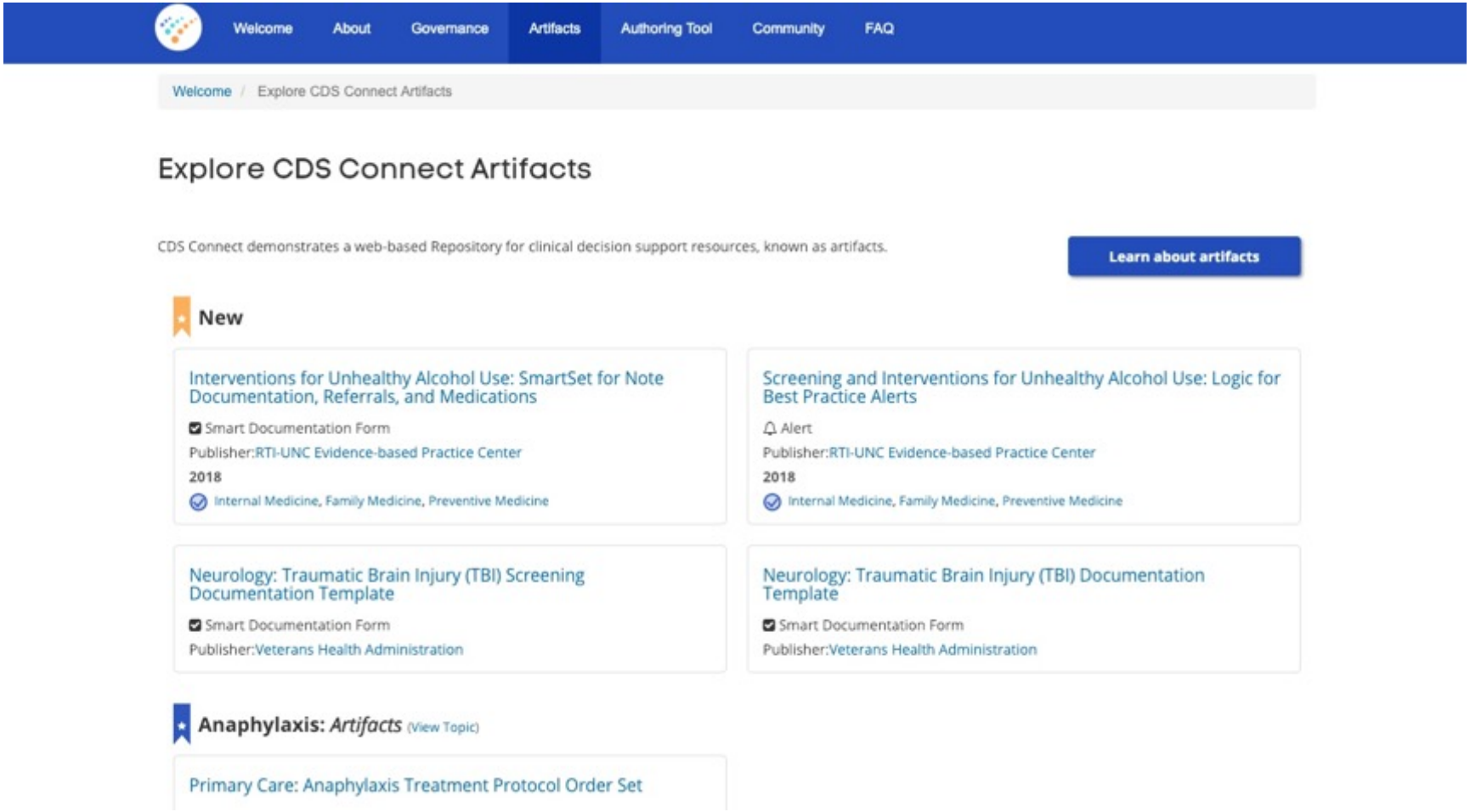

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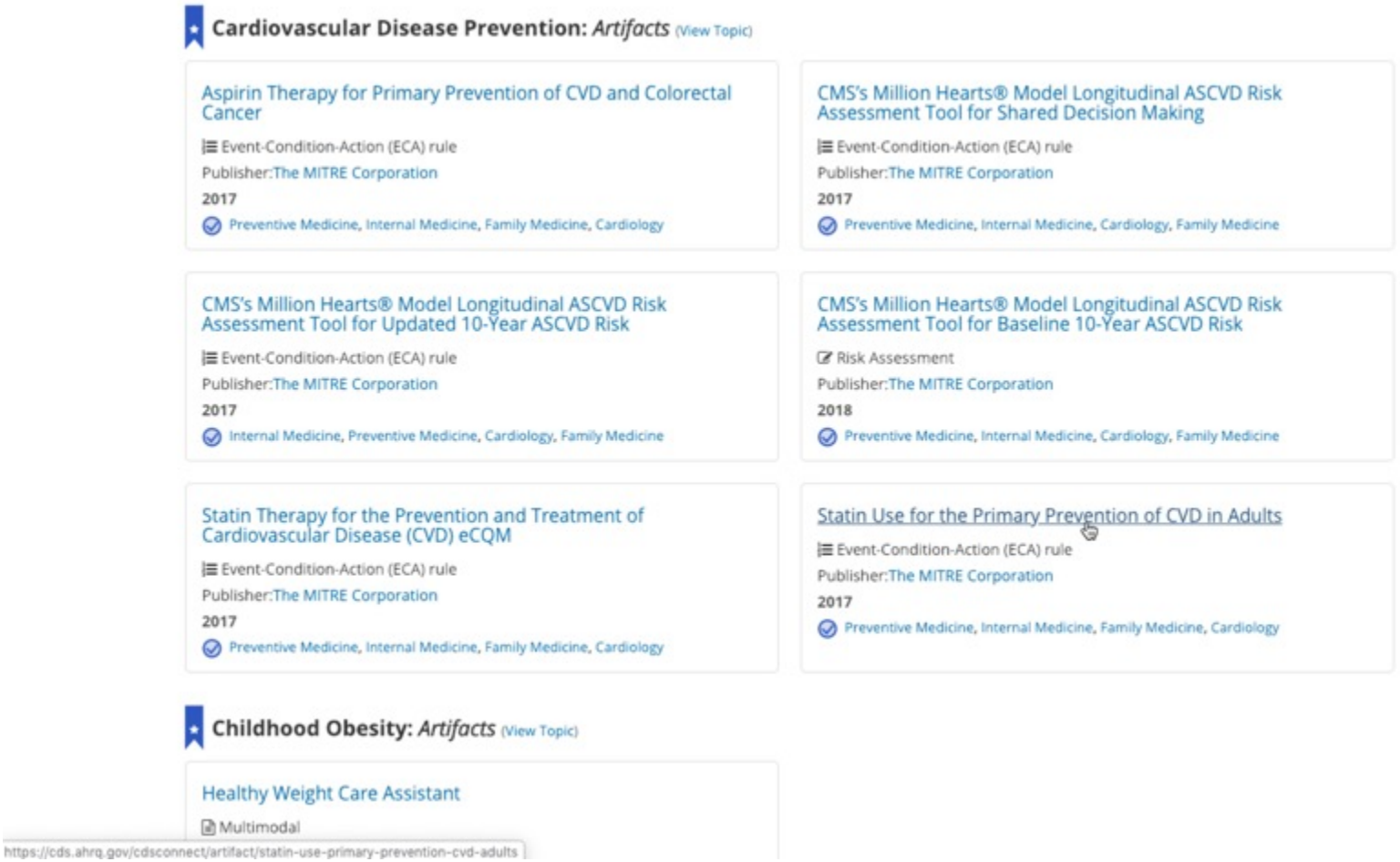

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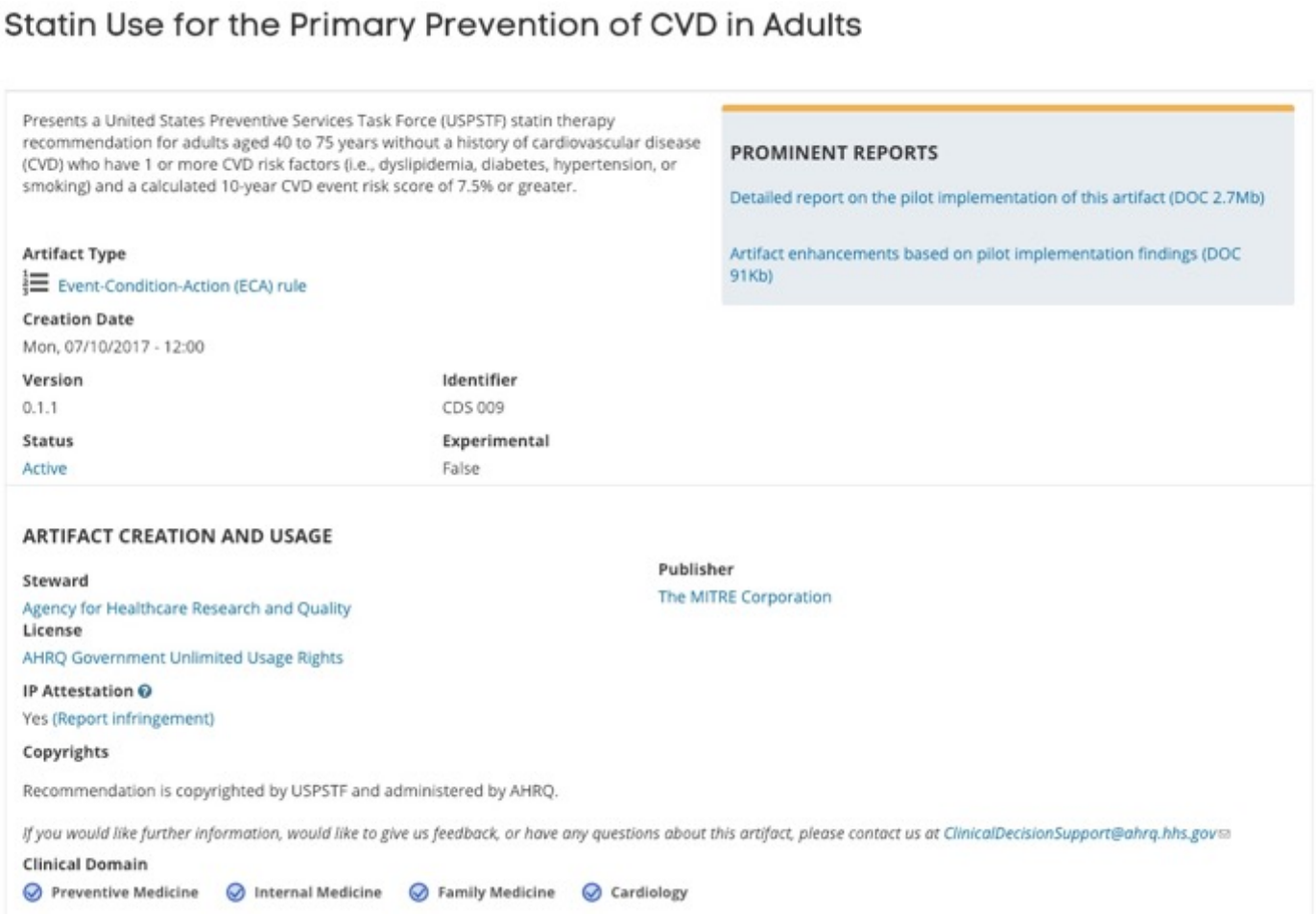


CDS Connect Repository

Inclusions

Patient is >=40 and <=75 years of age

AND 1 or more risk factor:

- LDL-C lab result > 130 mg/dL (MOST RECENT value within the past 6 years)
- OR HDL-C < 40 mg/dL (MOST RECENT value within the past 6 years)
- OR Diabetes (Type 1 or Type 2)
- OR Hypertension
- OR Smoking (MOST RECENT value within the past 6 years)

AND 10-Year CVD risk score >=7.5% (MOST RECENT value within the past 6 years)

Exclusions

Diagnosis of CVD

OR LDL-C lab result >190 mg/dL (MOST RECENT value within the past 6 years)

OR Known Familial Hypercholesterolemia

OR Diagnosis of Active Pregnancy OR Pregnancy Observation in the past 42 weeks

OR Diagnosis: Breastfeeding OR Breastfeeding Observation in the past year

OR Diagnosis of End Stage Renal Disease

OR Actively undergoing dialysis (i.e., within past 7 days)

OR Diagnosis of Active Cirrhosis

OR Already receiving a statin (Medication is Active or has been Ordered)

Interventions and Actions

Intervention **DISPLAY** notification to provider:

CDS Connect Repository

Intervention **DISPLAY** notification to provider:

1) **If CVD risk score >=7.5% and <10% (Grade C):**
Recommendation: **Discuss** initiation of low to moderate intensity lipid lowering therapy
Rationale: The USPSTF found adequate evidence that use of low- to moderate-dose statins reduces the probability of CVD events and mortality by at least a small amount in adults aged 40 to 75 years who have 1 or more CVD risk factors (dyslipidemia, diabetes, hypertension, or smoking) and a calculated 10-year CVD event risk of 7.5% to 10%.

2) If CVD risk score >=10% (Grade B):
Recommendation: **Start** low to moderate intensity lipid lowering therapy based on outcome of shared decision making between patient and provider
Rationale: The USPSTF found adequate evidence that use of low- to moderate-dose statins reduces the probability of CVD events (MI or ischemic stroke) and mortality by at least a moderate amount in adults aged 40 to 75 years who have 1 or more CVD risk factors (dyslipidemia, diabetes, hypertension, or smoking) and a calculated 10-year CVD event risk of 10% or greater.

3) If Does Not Meet Inclusion Criteria:
Recommendation: No USPSTF recommendation provided, as patient does not meet inclusion criteria
Rationale: The USPSTF guideline applies to adults aged 40 to 75 years who have 1 or more CVD risk factors (dyslipidemia, as evidenced by LDL > 130 mg/dL or HDL < 40 mg/dL, diabetes, hypertension, or smoking) and a calculated 10-year CVD event risk >= 7.5% (grade C) or >= 10% (grade B)

4) Is Excluded:
Recommendation: No USPSTF recommendation provided, as patient meets exclusion criteria
Rationale: This USPSTF guideline should not be used for patients with any of the following: LDL > 190 mg/dL, a previous CVD diagnosis or procedure, familial hypercholesterolemia, end stage renal disease, cirrhosis, recent dialysis, or patients who are pregnant, breastfeeding, or currently on a statin.

5) Error Message When Missing Data But CDS Can Still Be Processed Enough To Get An Answer
WARNING: Adequate data to process CDS, but one of the following items is missing or more than 6 years old: LDL, HDL, smoking status, or CVD risk score.

6) Error Message When Missing Data Prevents CDS From Being Processed
ERROR: Inadequate data to process CDS, as one of the following items is missing or more than 6 years old: LDL, HDL, smoking status, or CVD risk score.

CDS Connect Repository

Action	**REQUEST** medication order
Action	**DOCUMENT** any new medications on the active medication list
Action	**DOCUMENT** provider response if a reason for not prescribing a statin is provided
Intervention	**DISPLAY** link to relevant recommendation statement available at: https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/statin-use-in-adults-preventive-medication1?ds=1&s=statin
Intervention	**DISPLAY** link to reference information: http://jamanetwork.com/journals/jama/fullarticle/2584058
Intervention	**DISPLAY** link to statin shared decision making tool (e.g. Mayo Clinic Shared Decision Making National Resource Center at: http://shareddecisions.mayoclinic.org/discussion/the-new-statin-choice-decision-aid/)
Intervention	**DISPLAY** link to education materials that are relevant to the patient's plan of care

Logic Files

TESTING EXPERIENCE

Pilot Experience

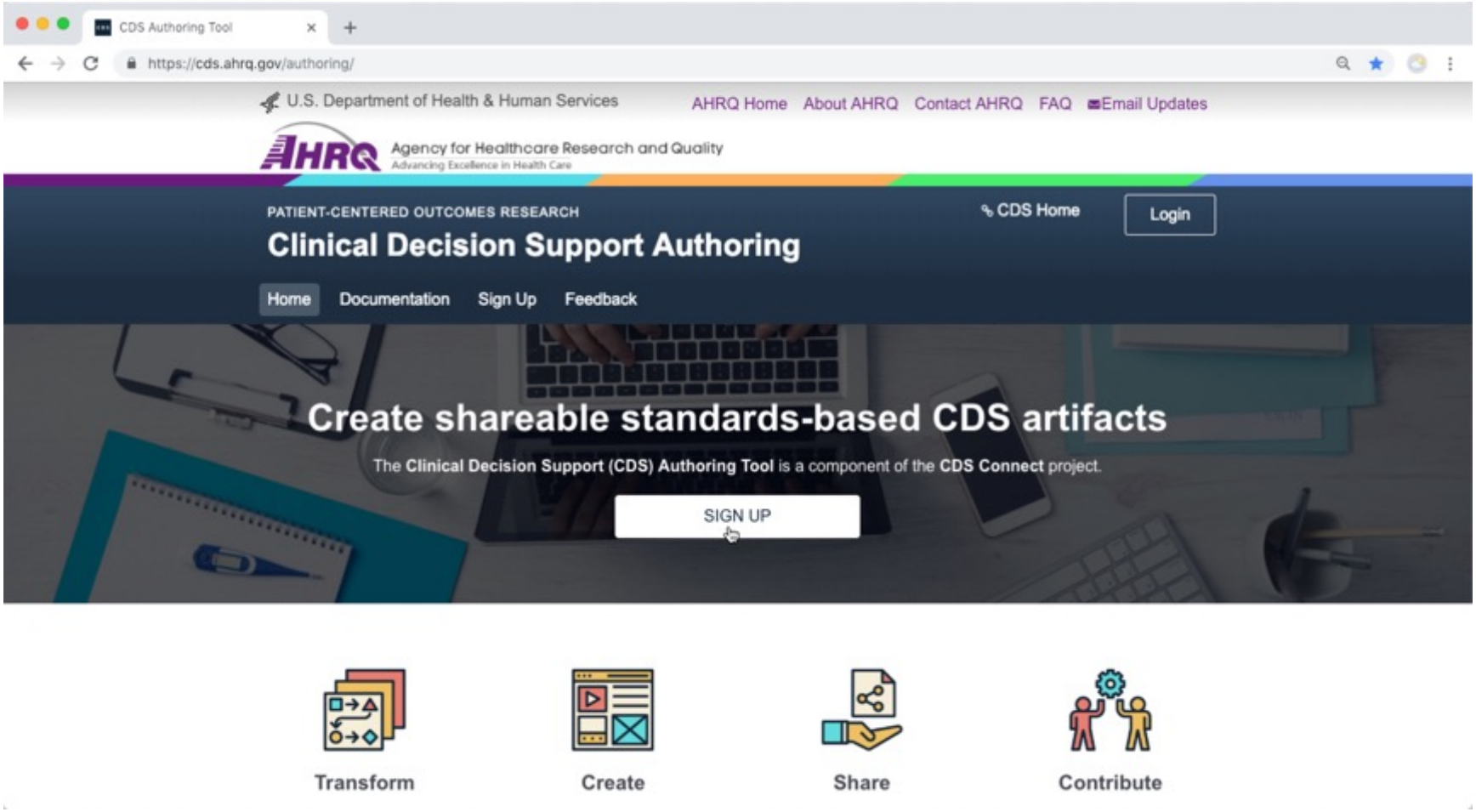
This artifact underwent integration testing and an 8-week pilot implementation at a Federally Qualified Health Center (FQHC) affiliated with AllianceChicago in July-August 2017. The artifact performed reliably and consistently produced appropriate notifications and interventions to clinical providers.

Please see attached documents in the Implementation Detail section of the repository to view the Pilot Report and the list of enhancements made to the artifact based on the pilot implementation.

https://cds.ahrq.gov/sites/default/files/cds/artifact/logic/2018-12/USPSTF_Statin_Use_for_Primary_Prevention_of_CVD_in_Adults_FHIRv102_v1.0.1_CQL.zip

CDS Authoring Tool

CDS Authoring Tool



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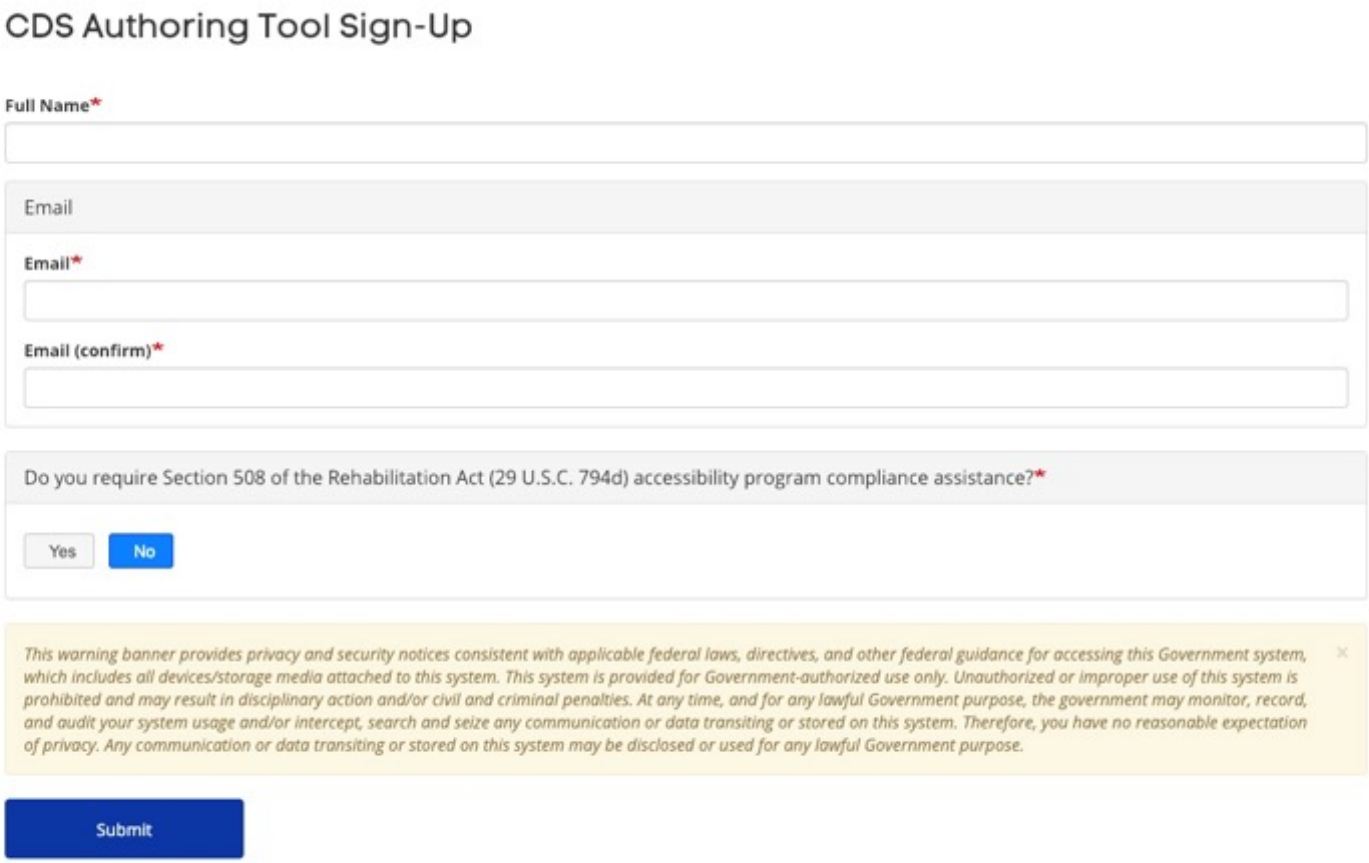

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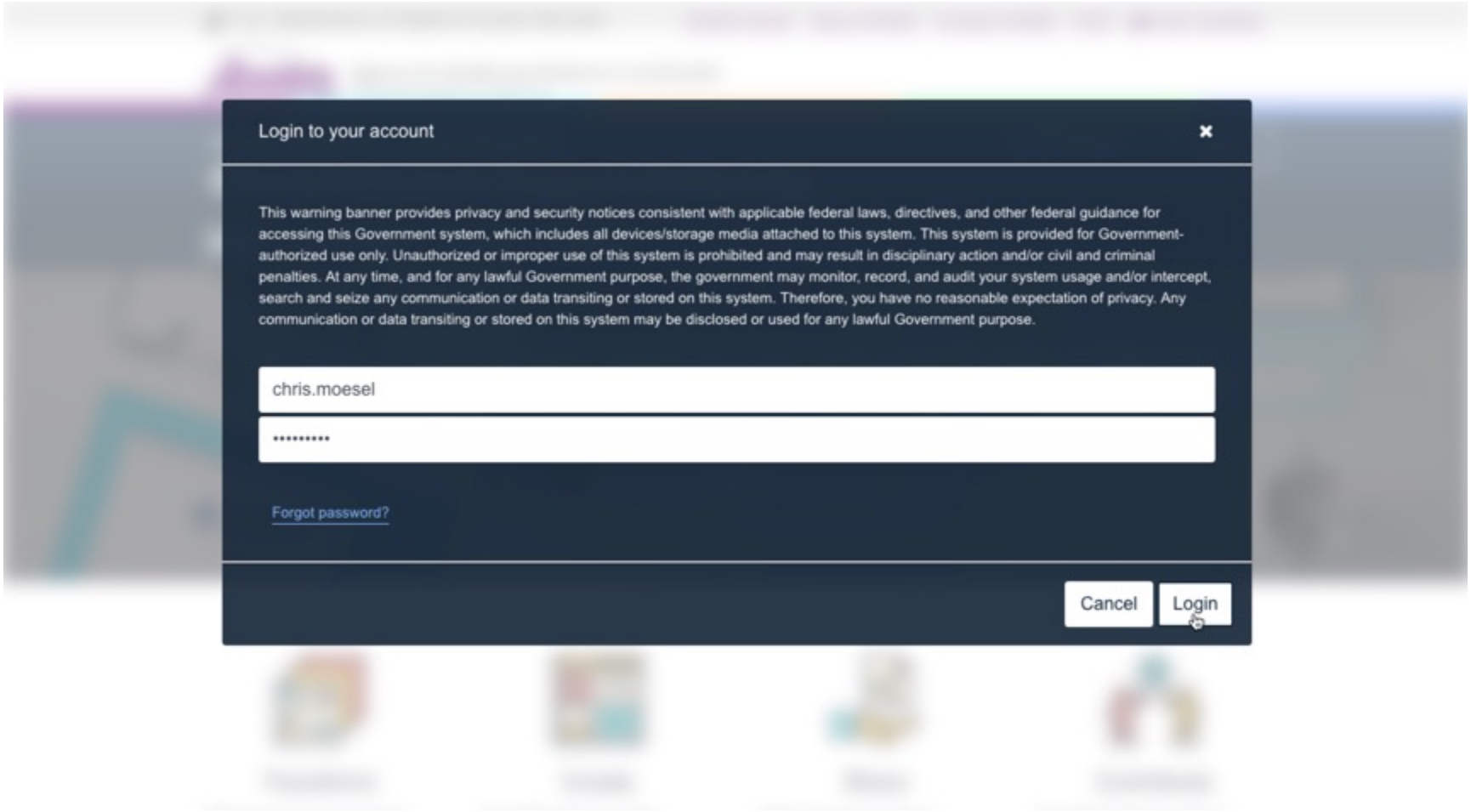

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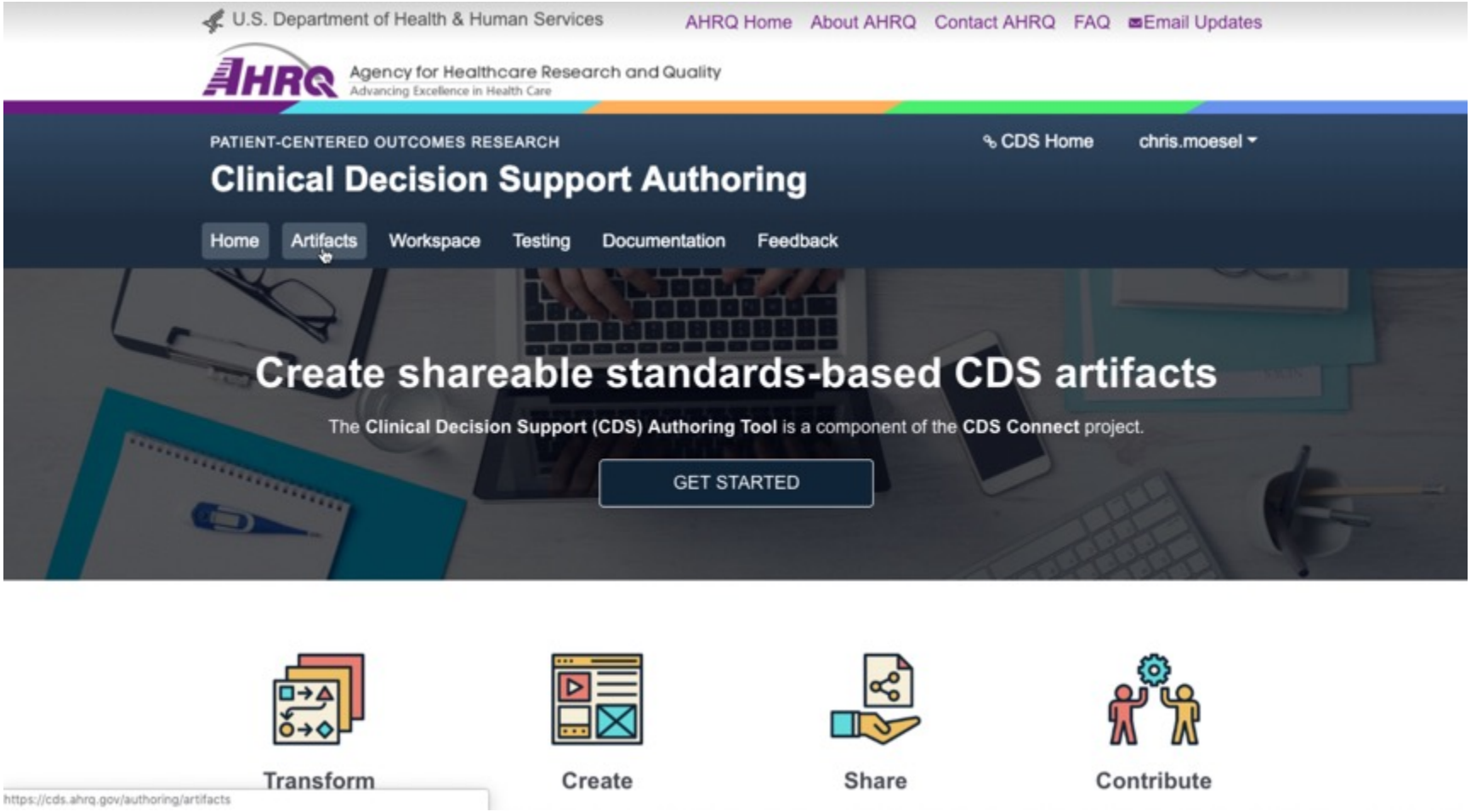
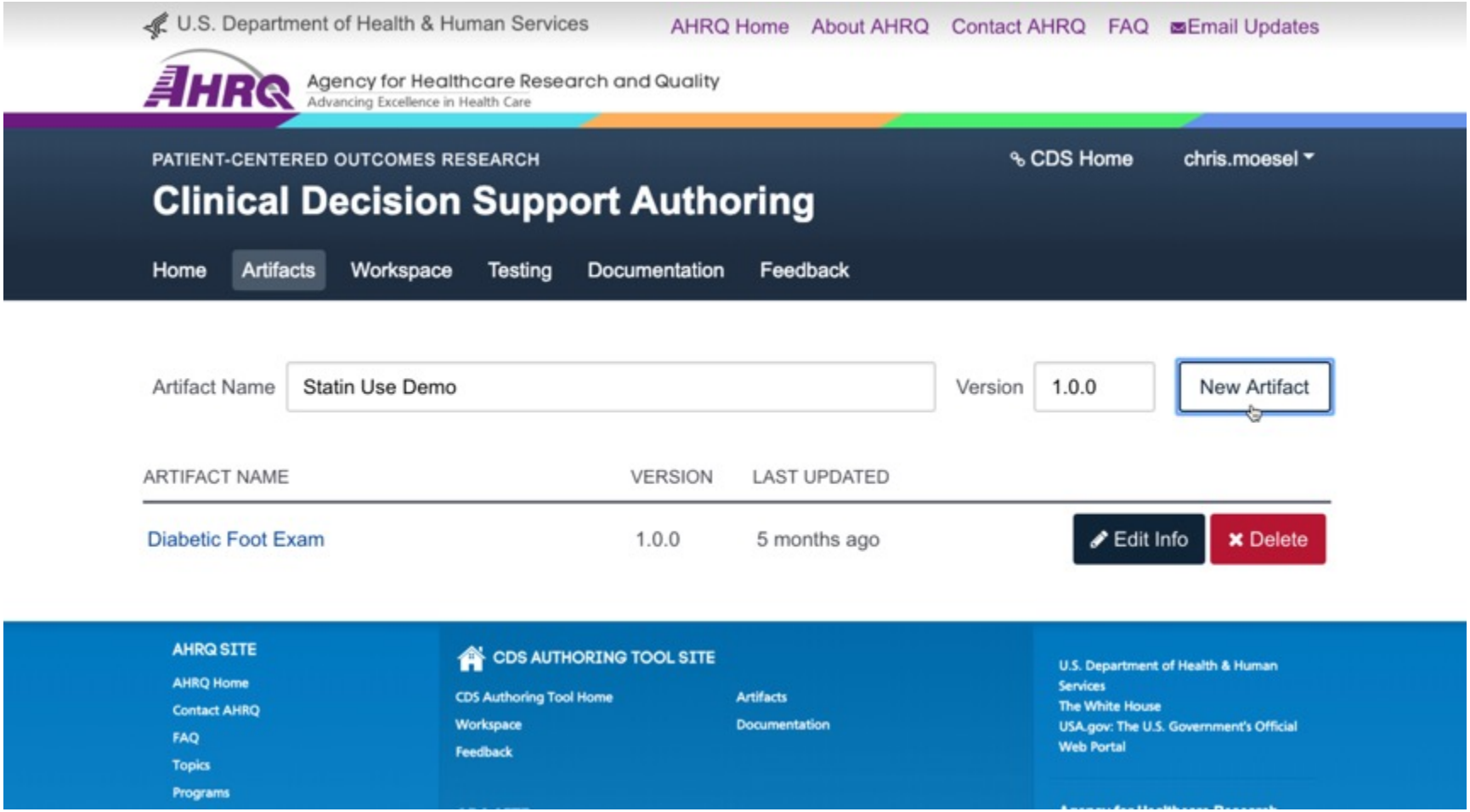


CDS Authoring Tool: Artifacts



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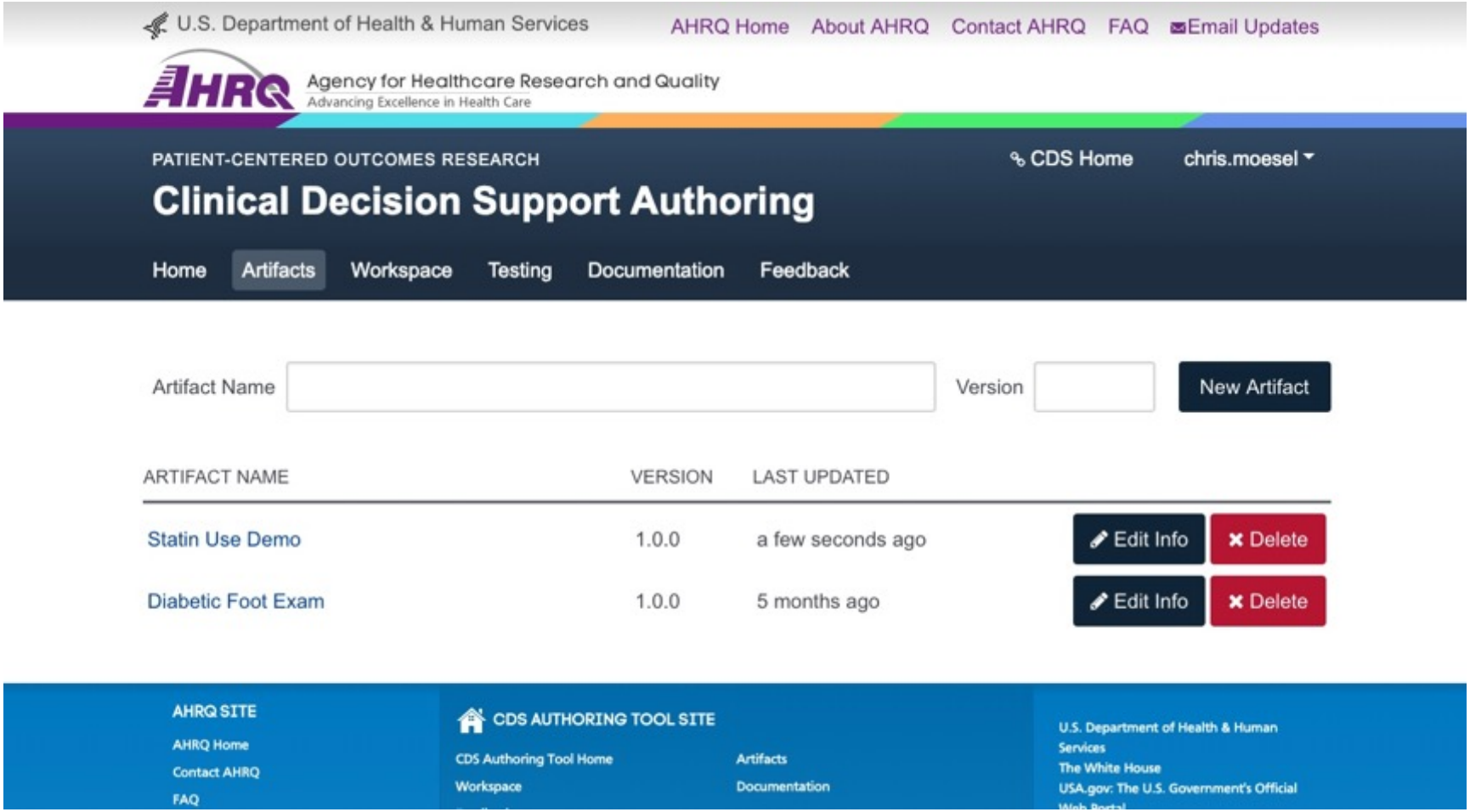
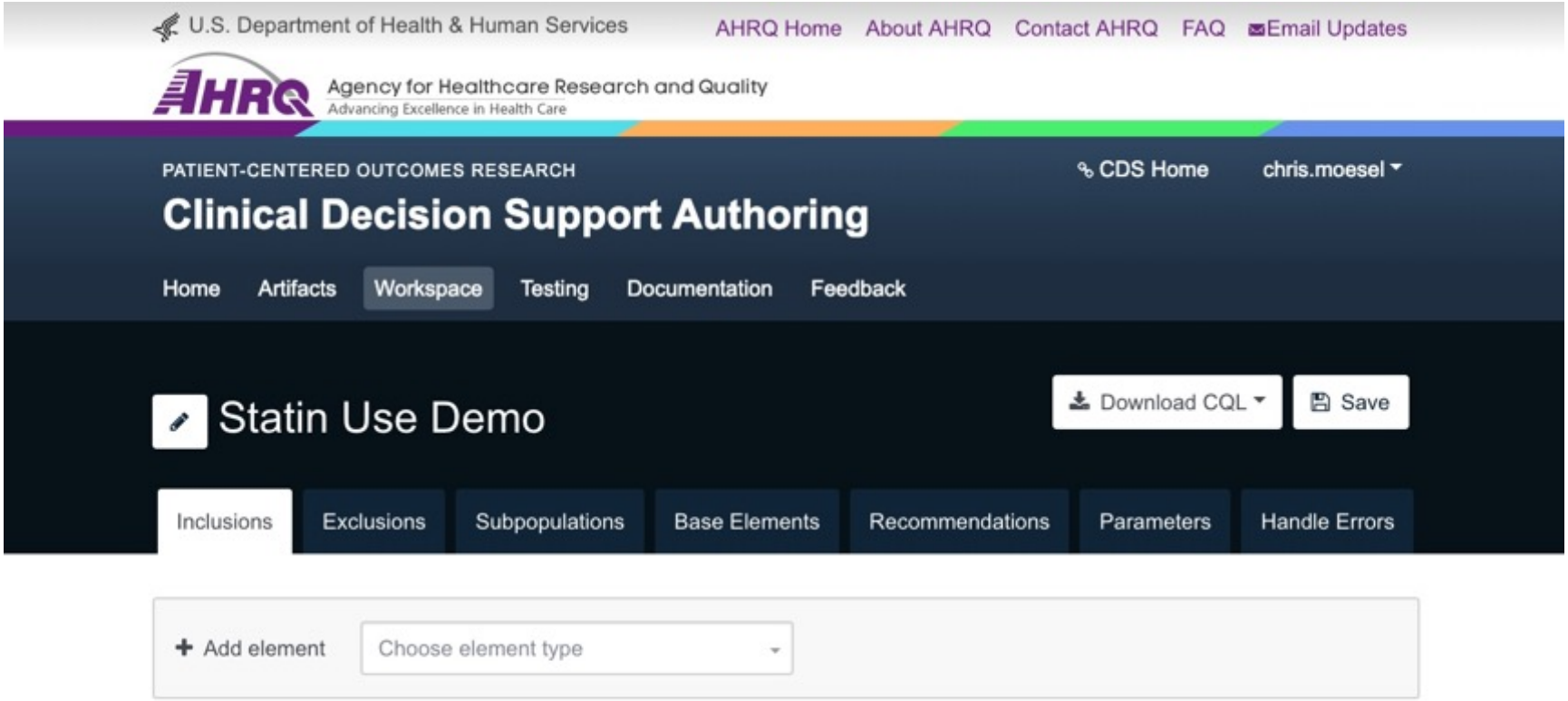


CDS Authoring Tool: Workspace



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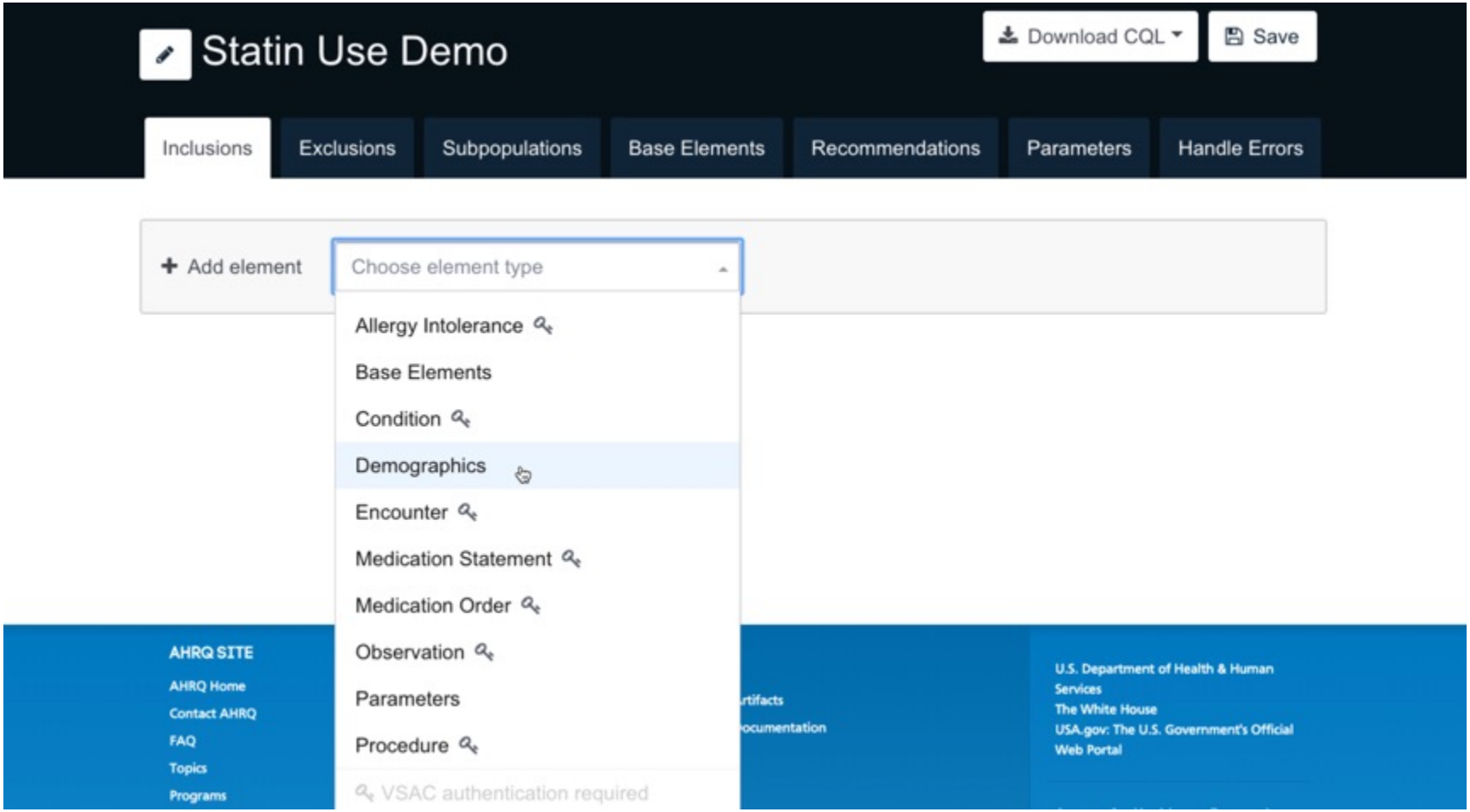

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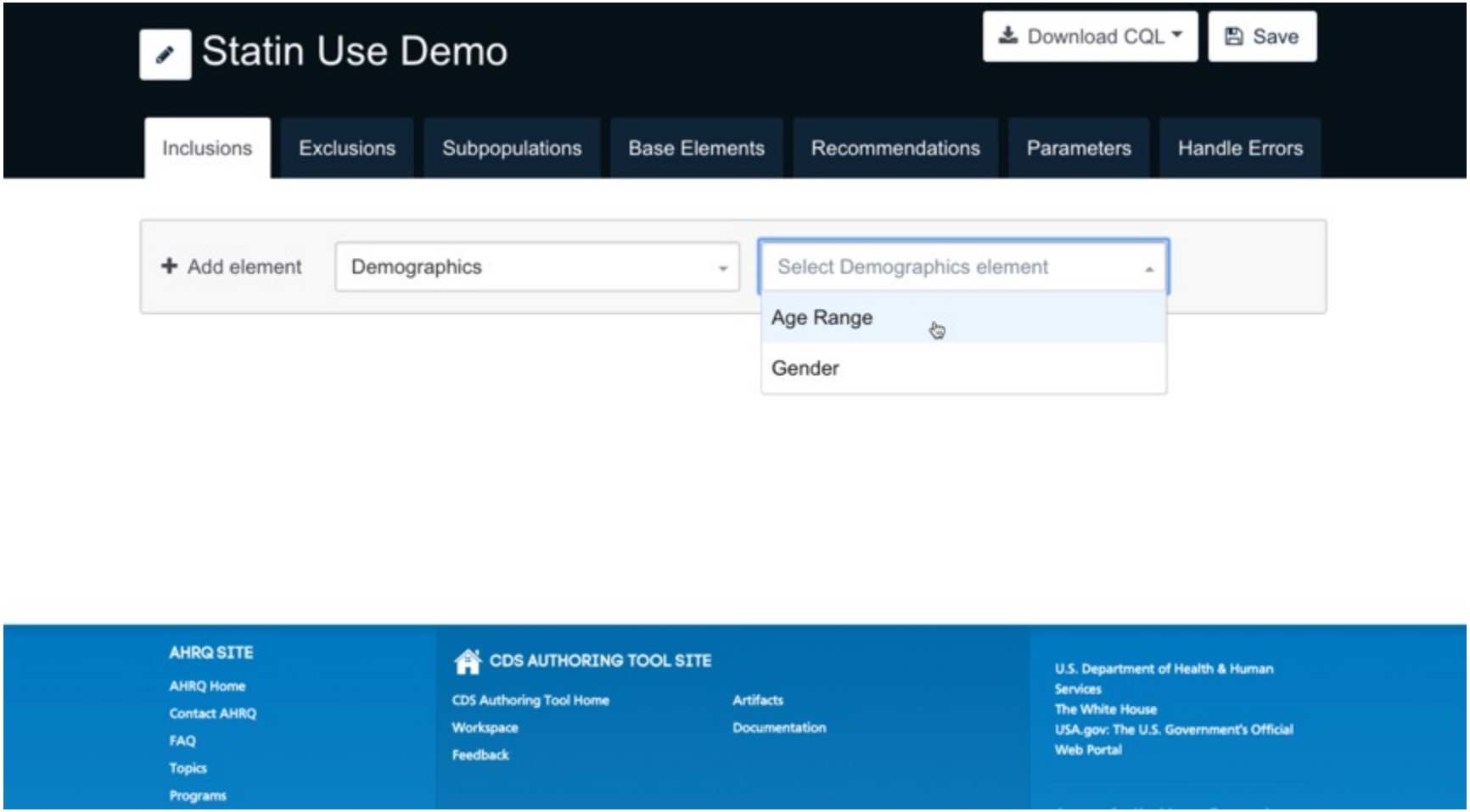

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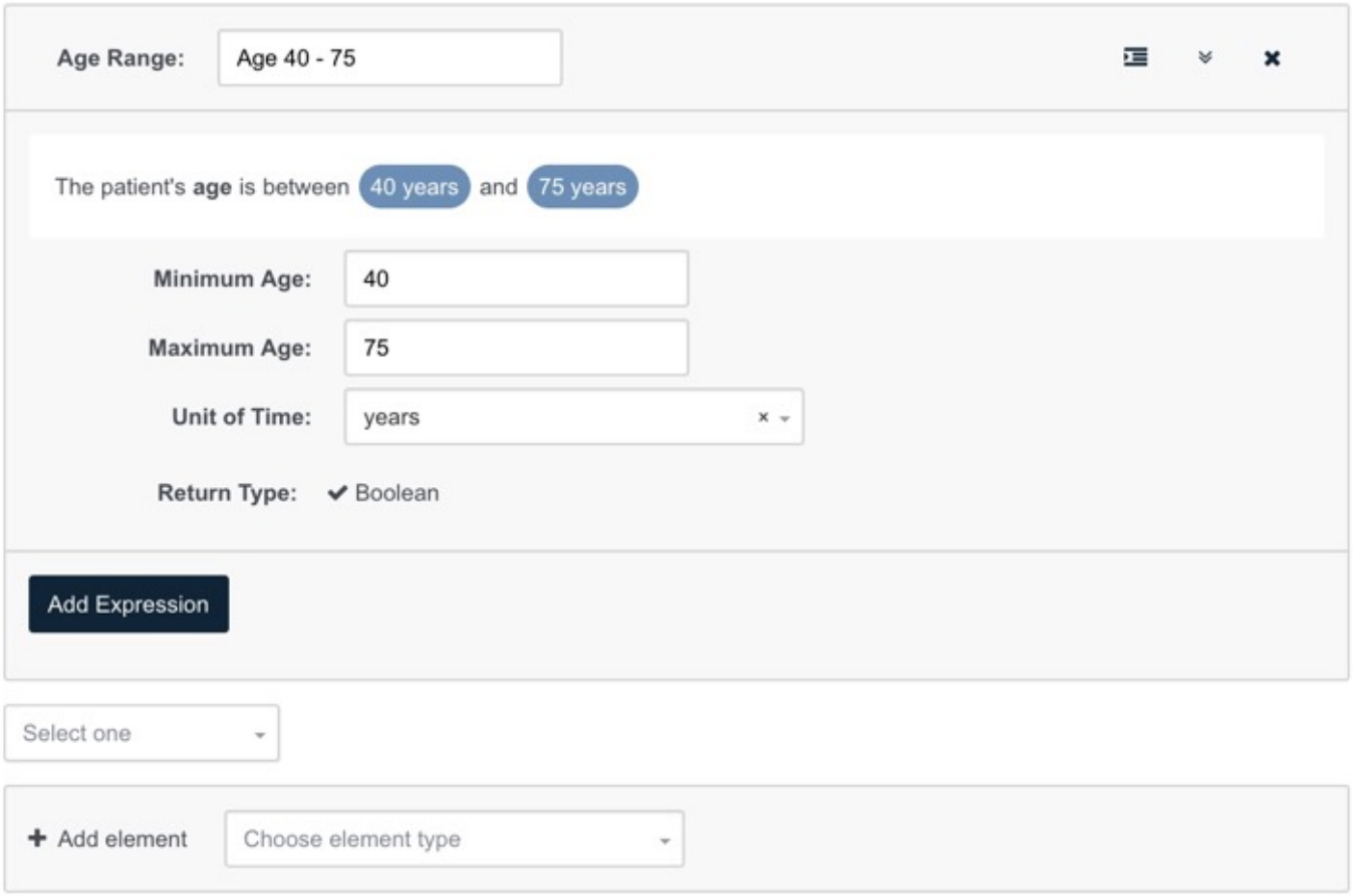

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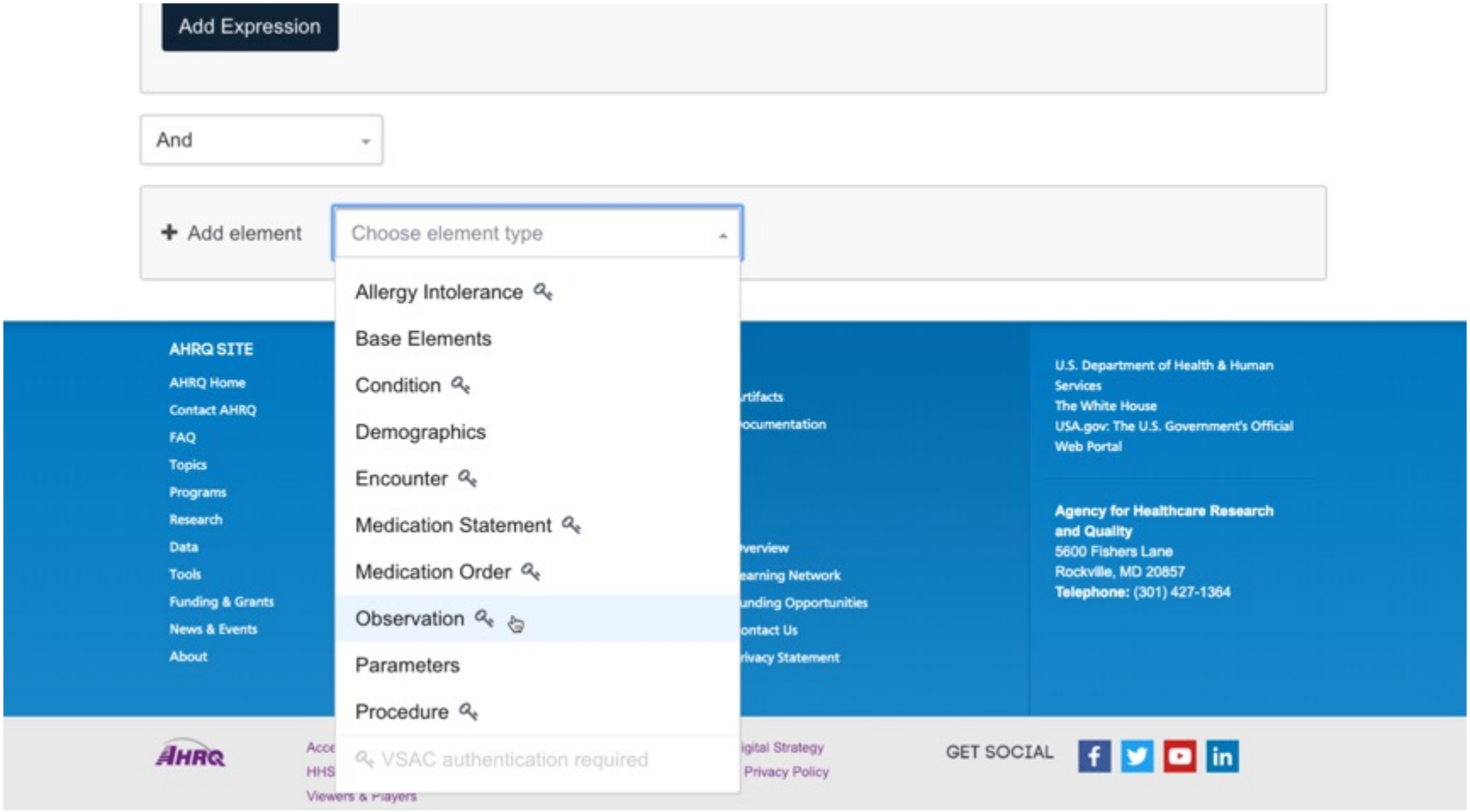

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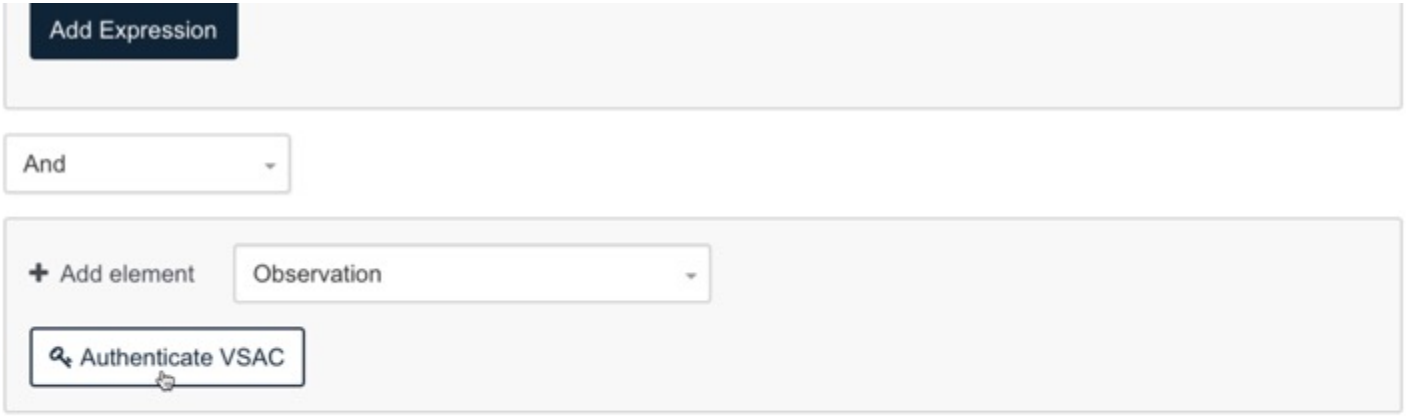

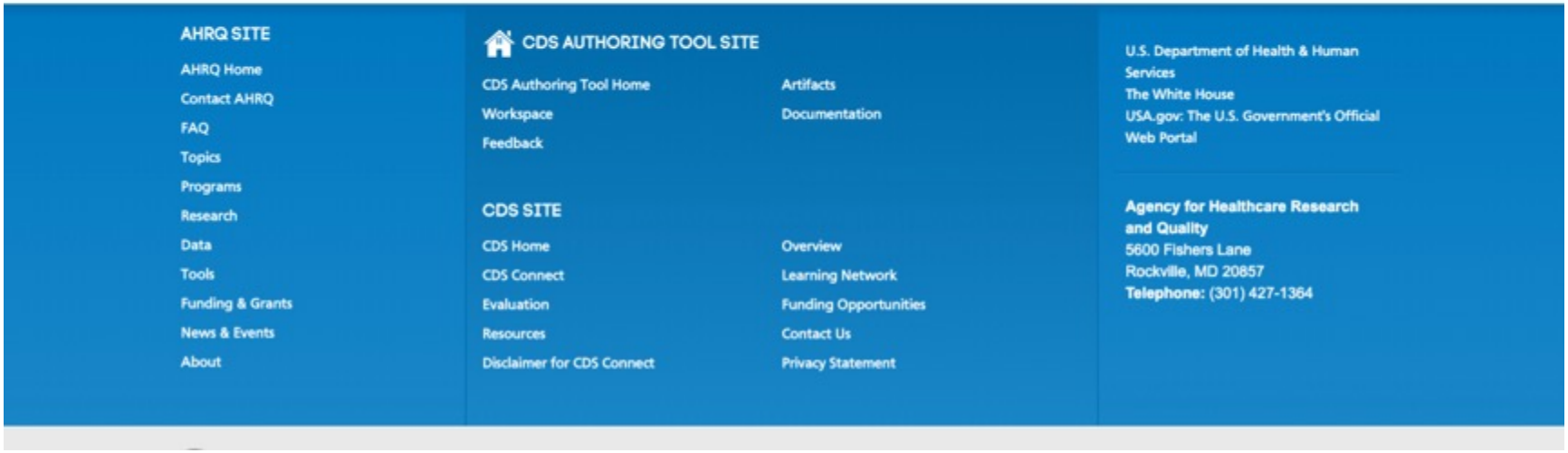

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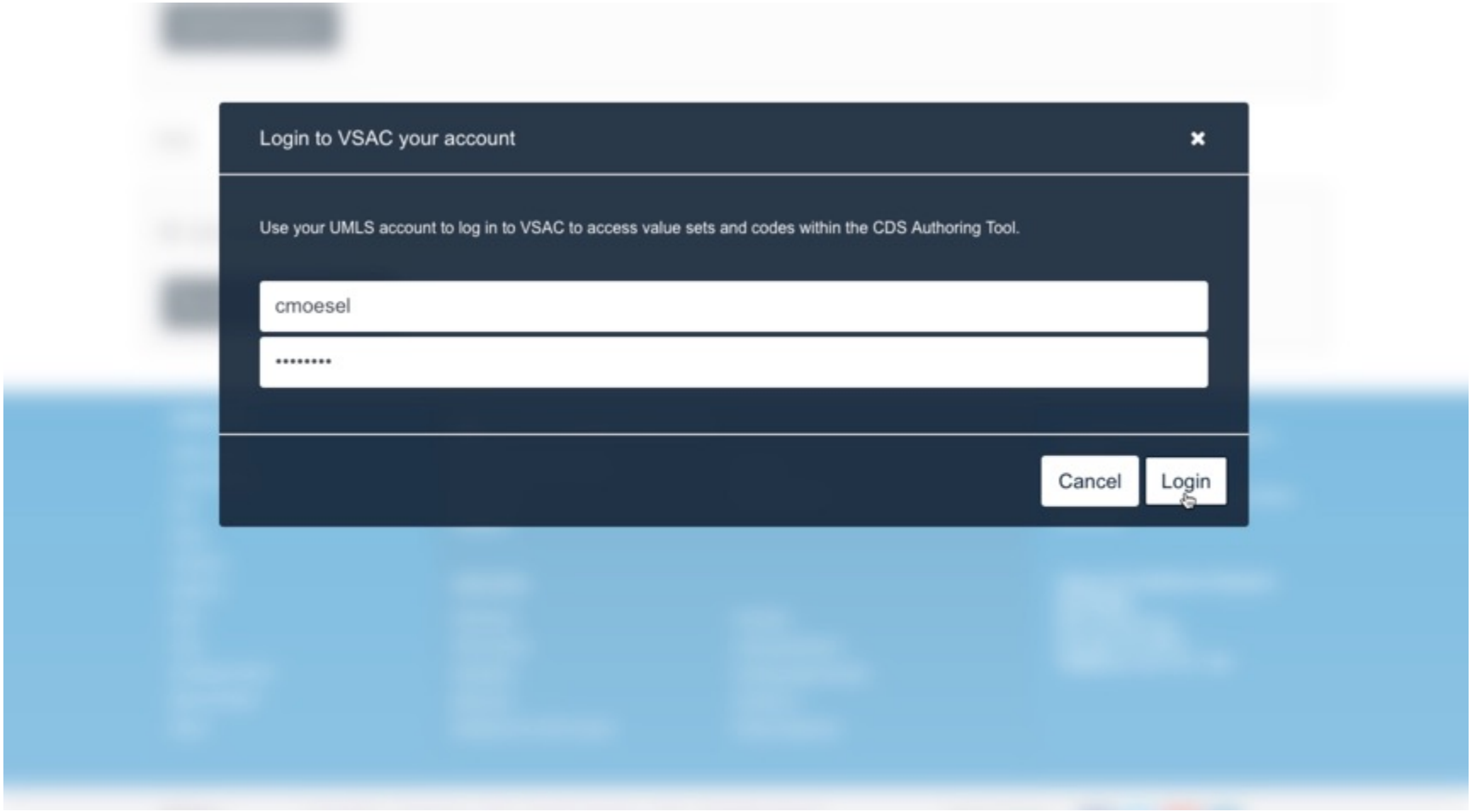

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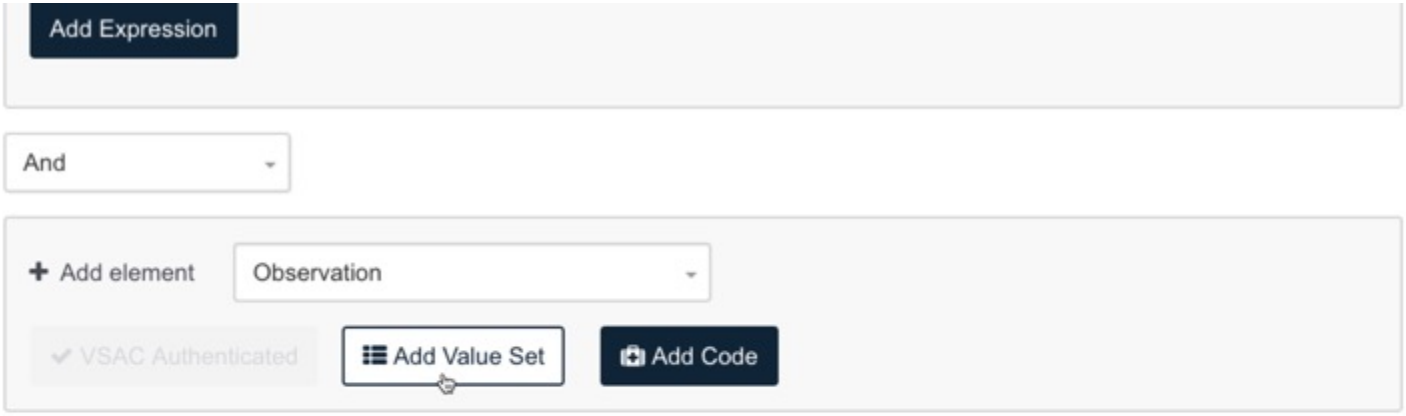

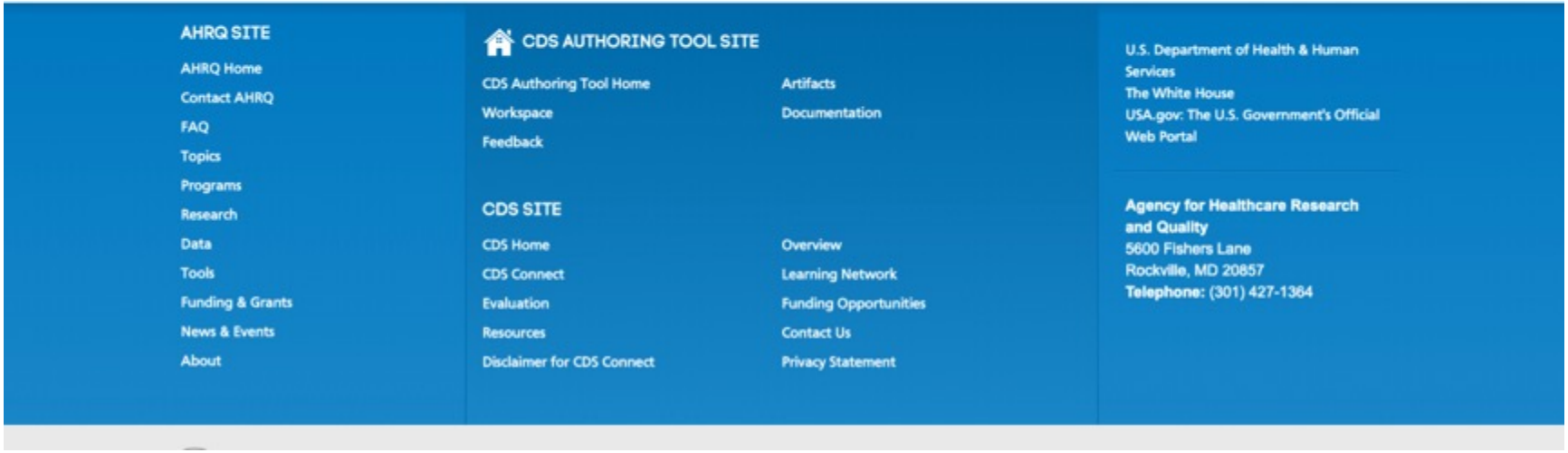

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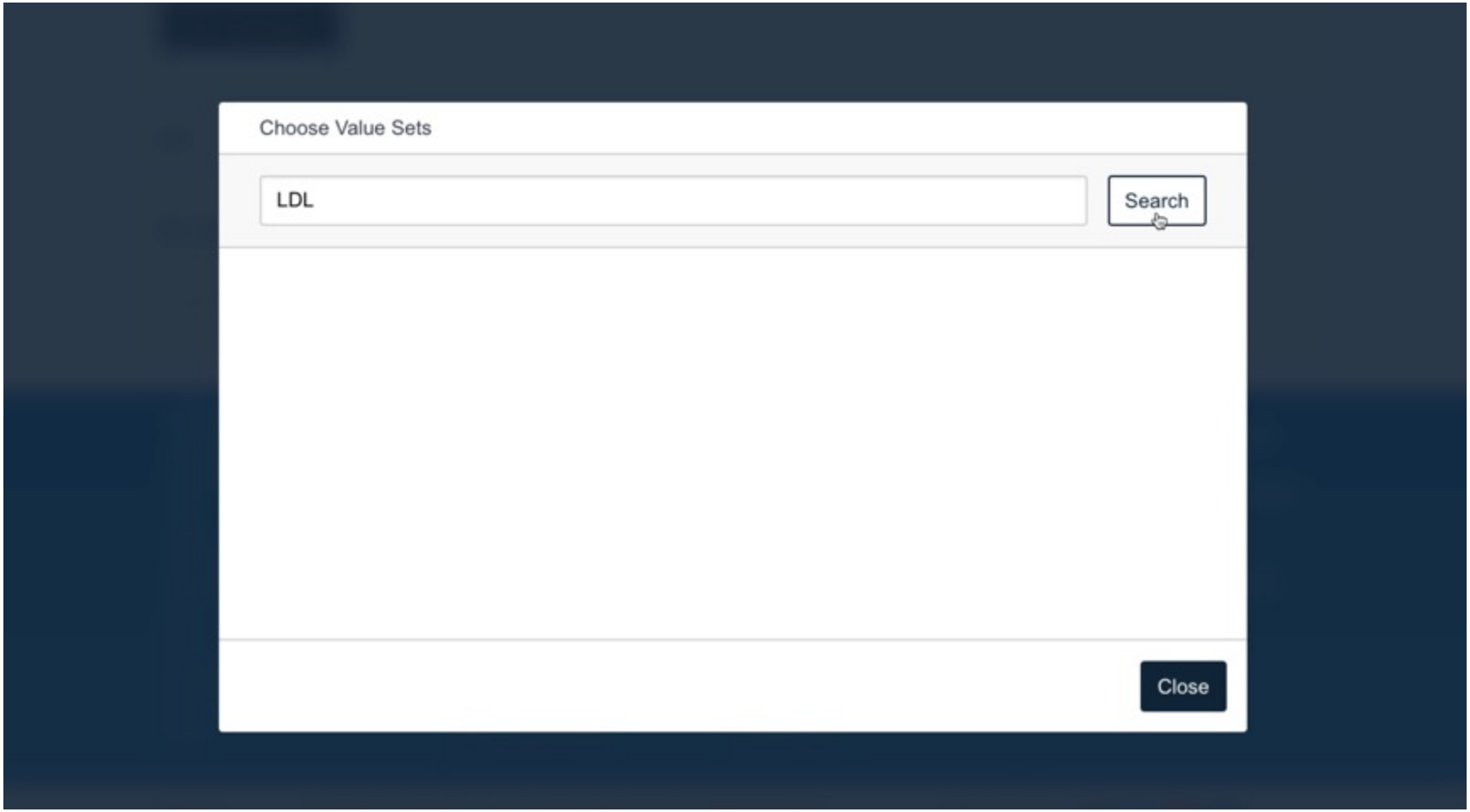

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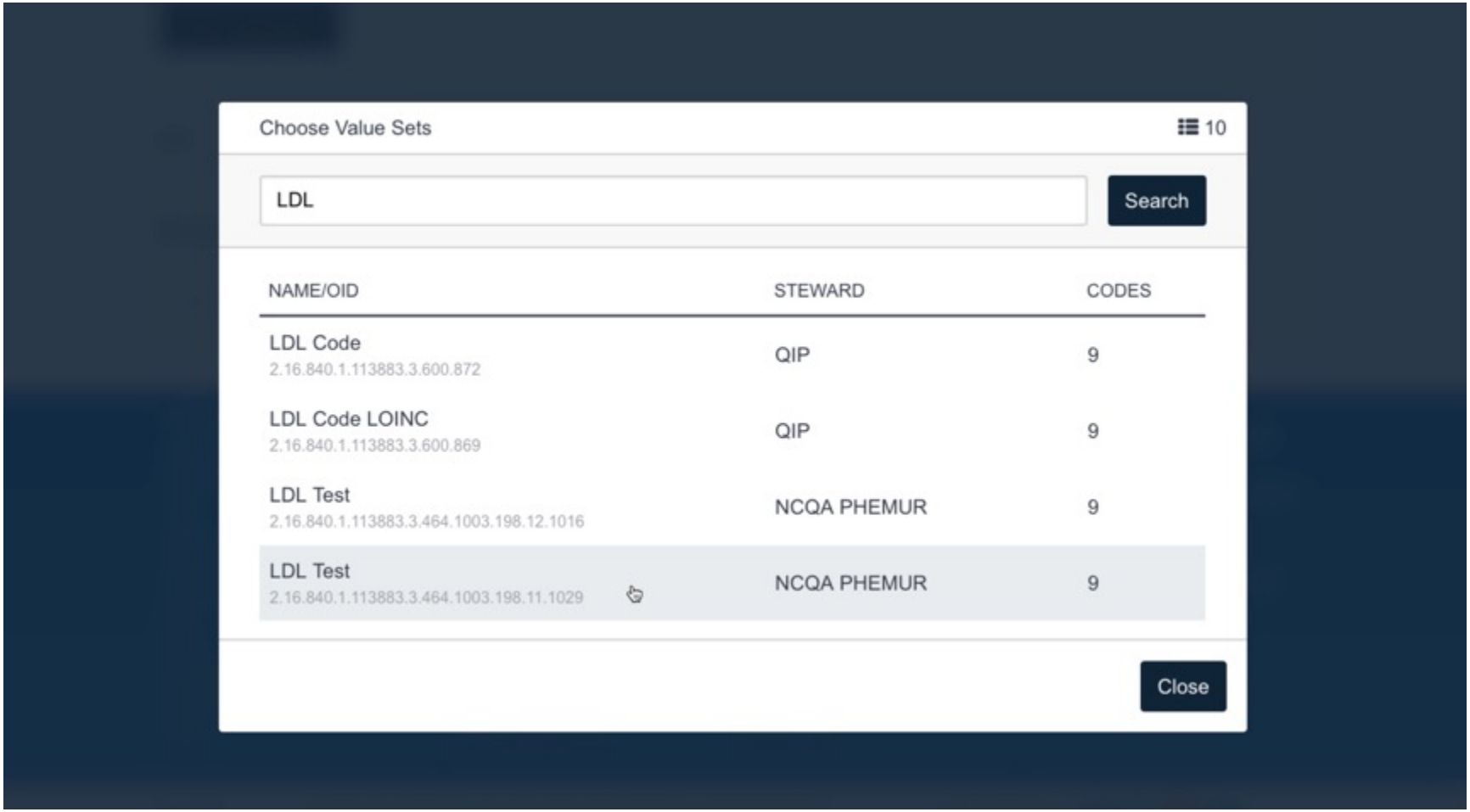

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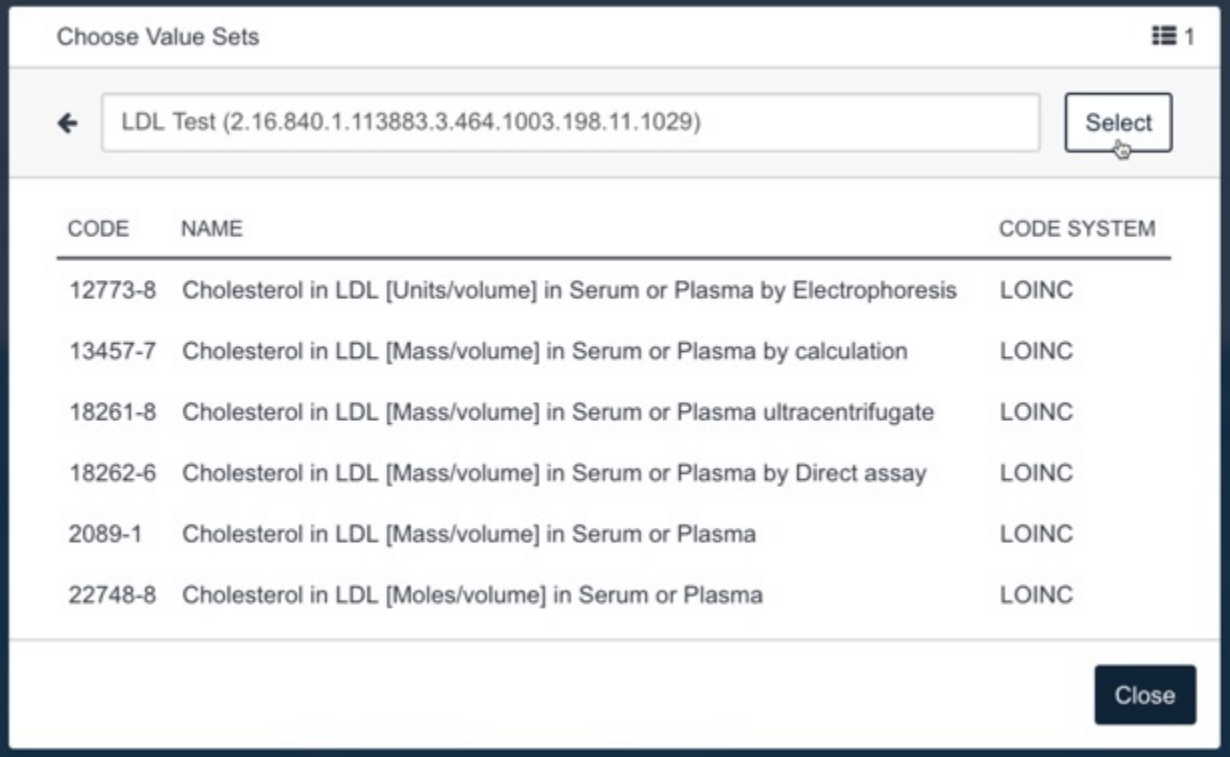
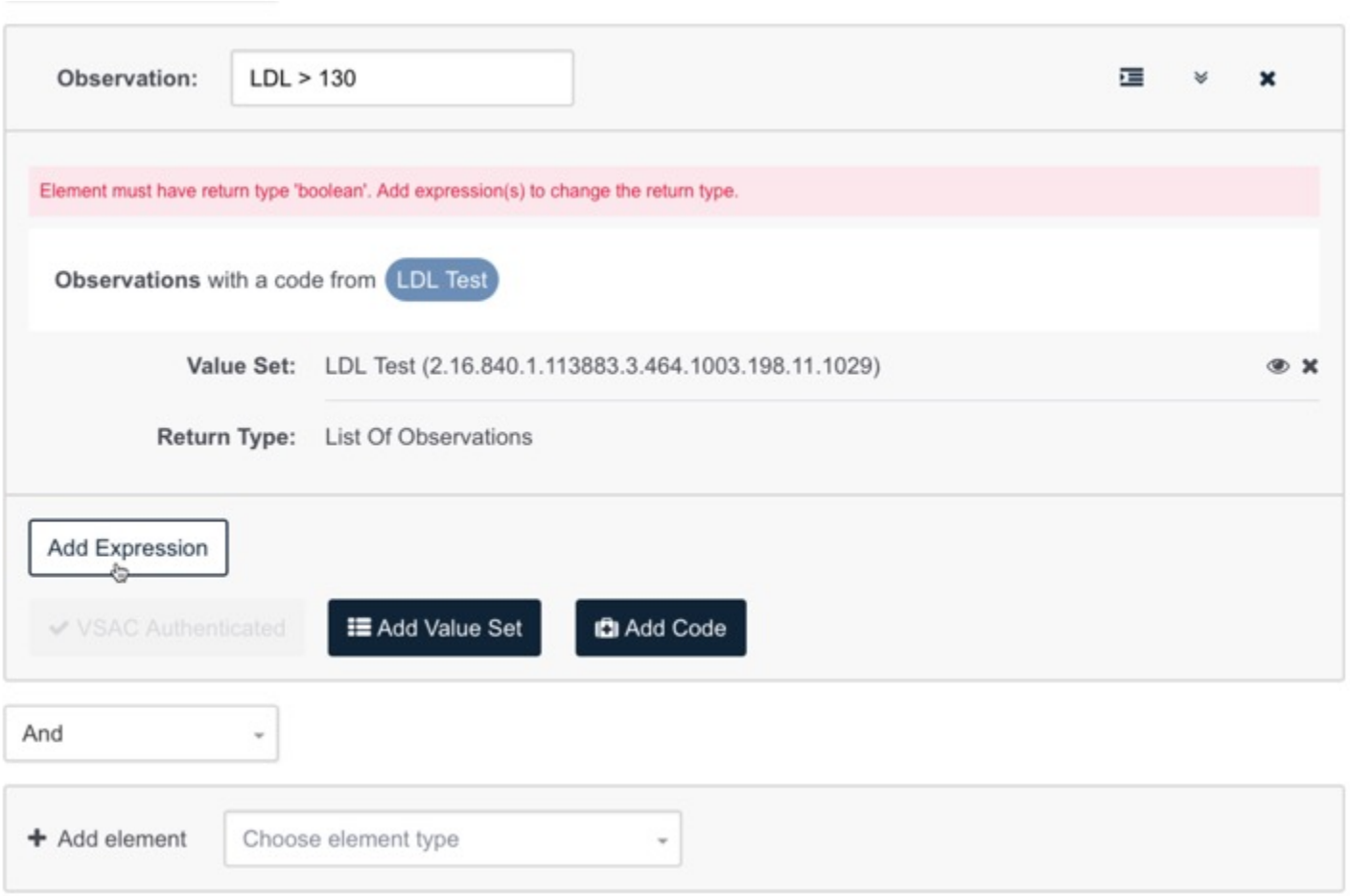


CDS Authoring Tool: Inclusions



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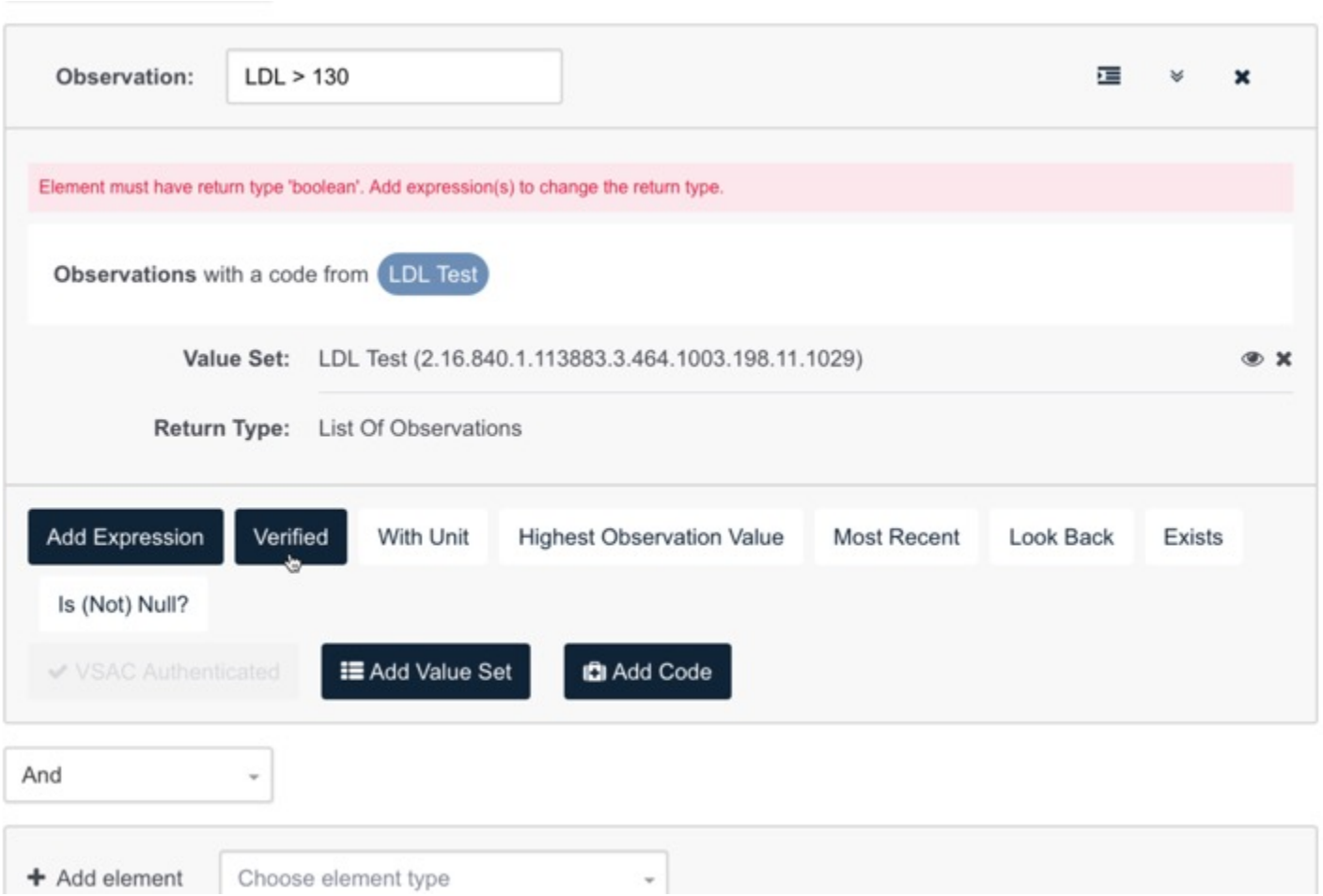

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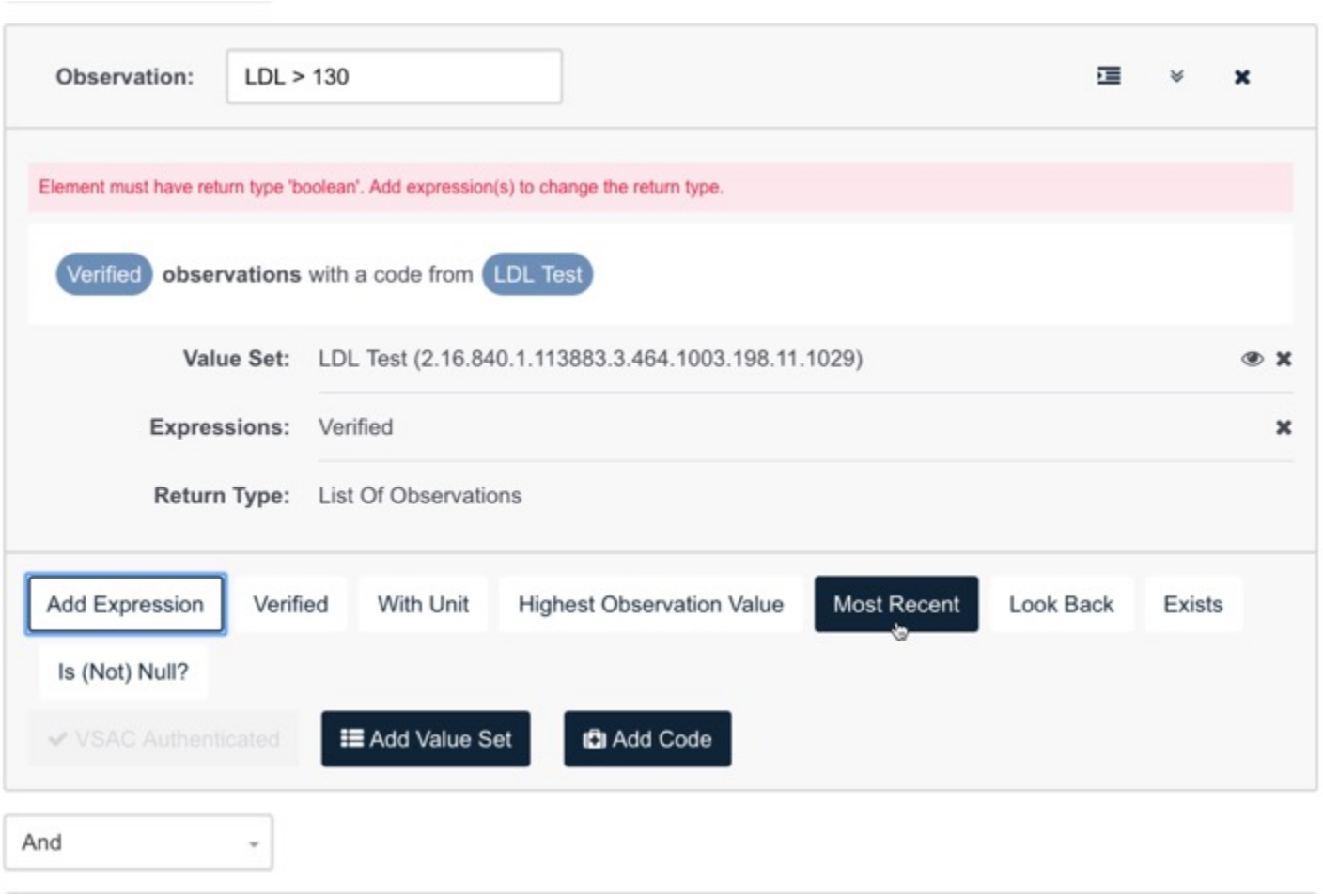

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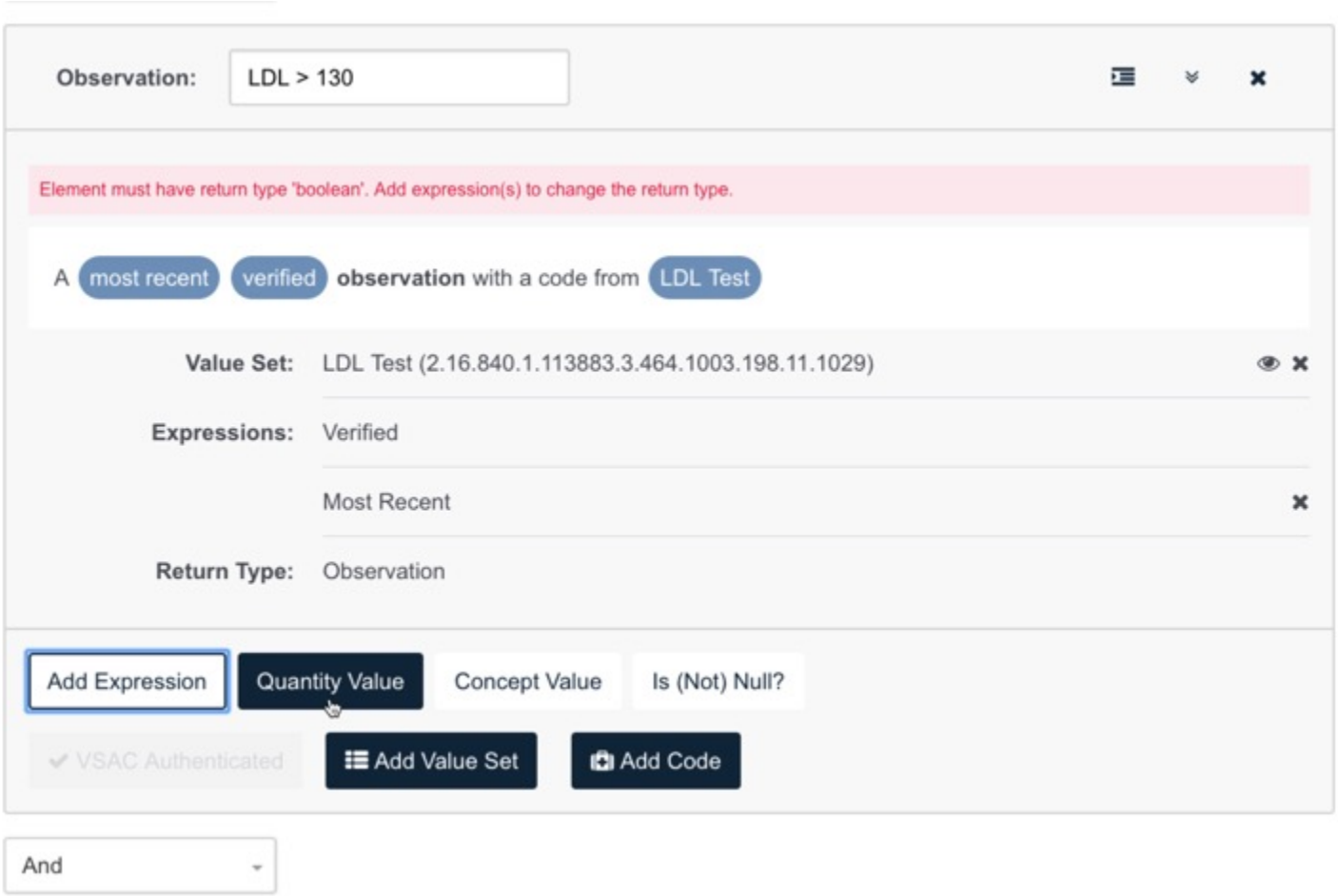

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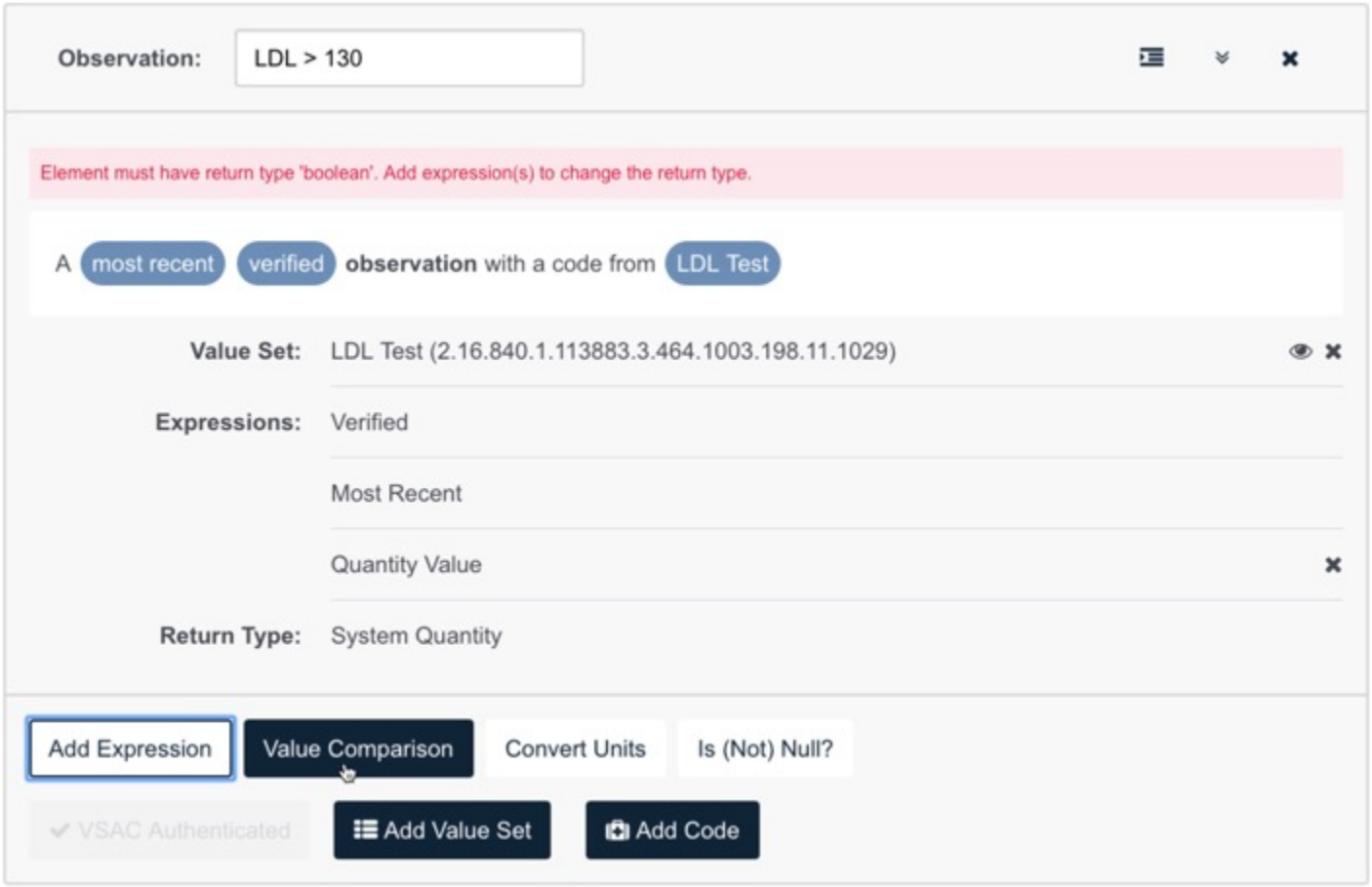

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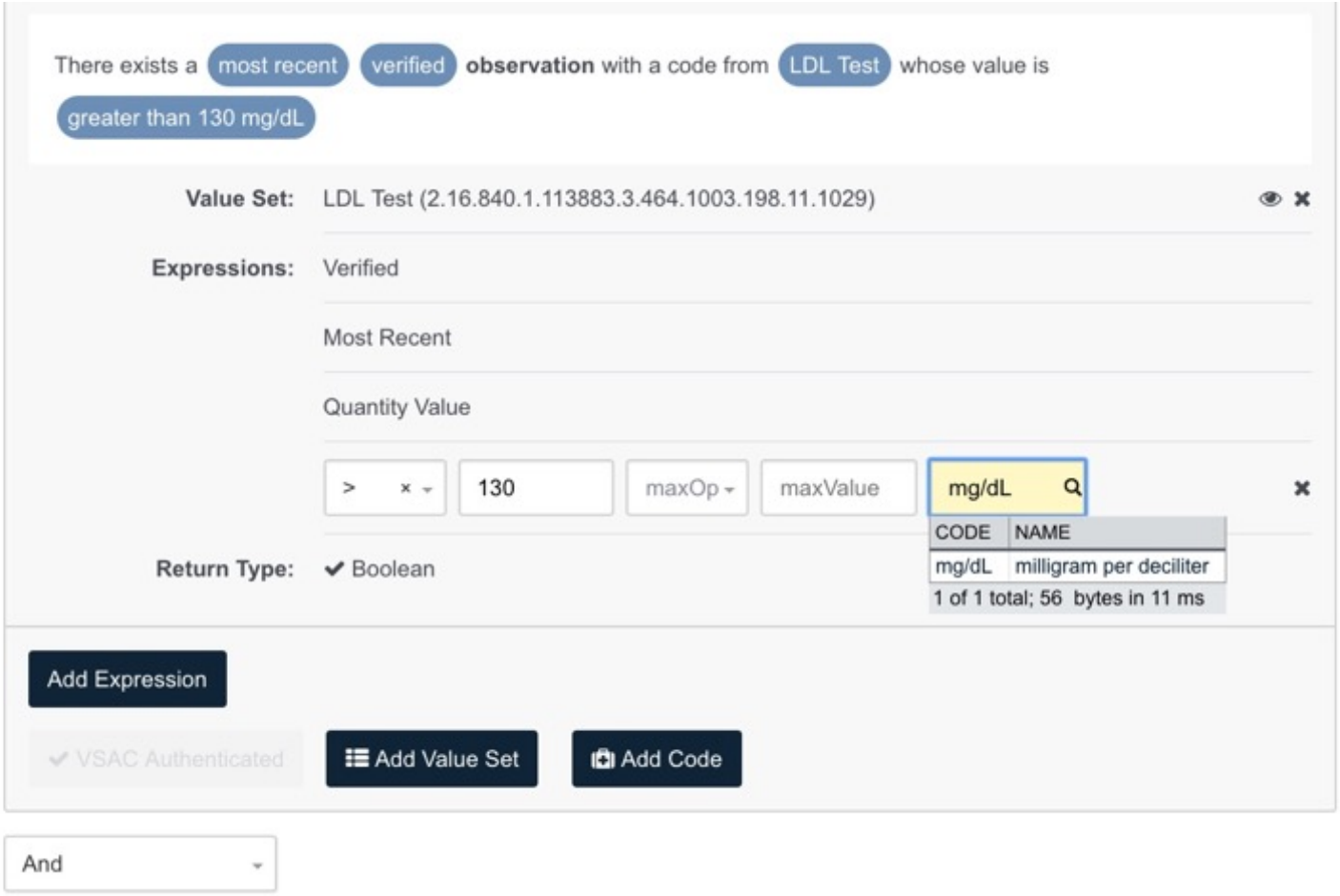
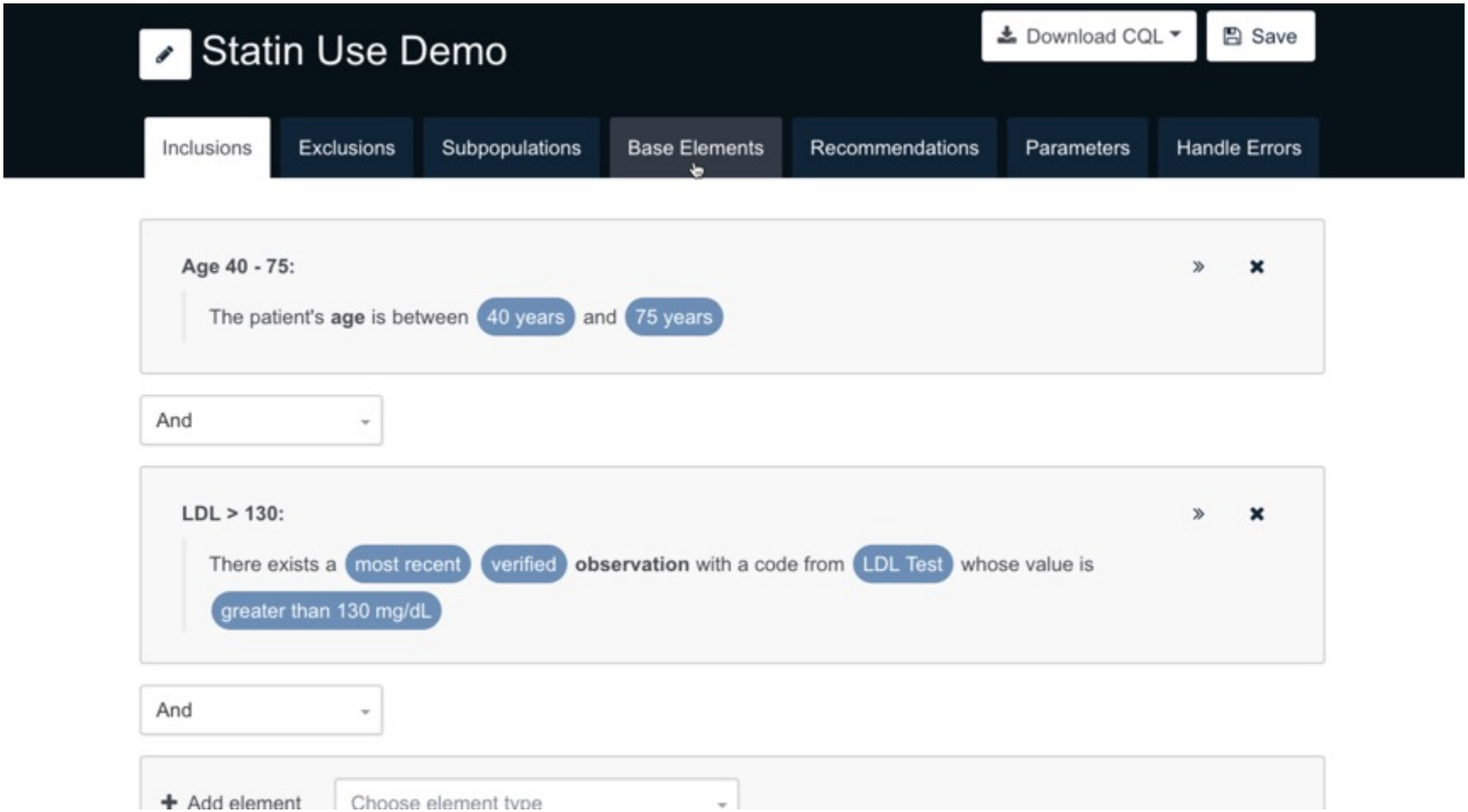


CDS Authoring Tool: Base Elements



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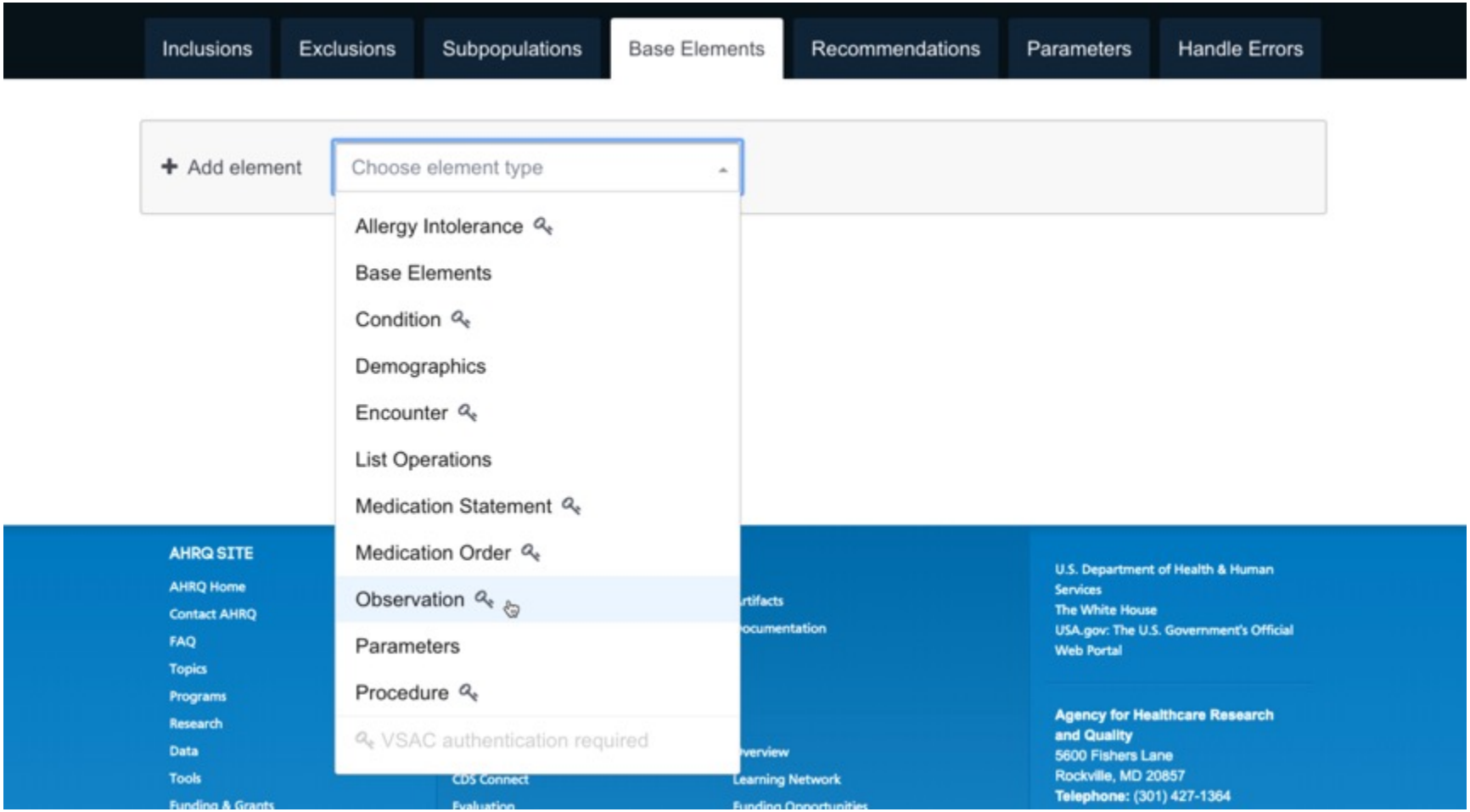

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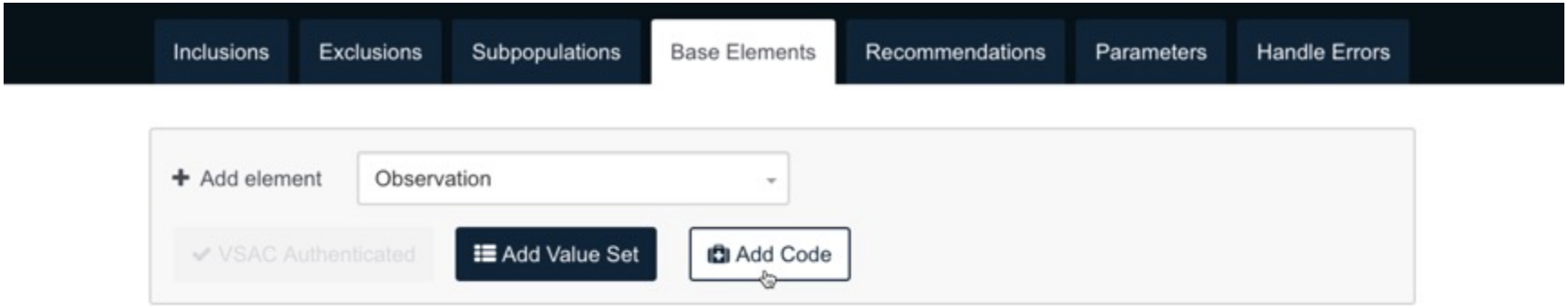

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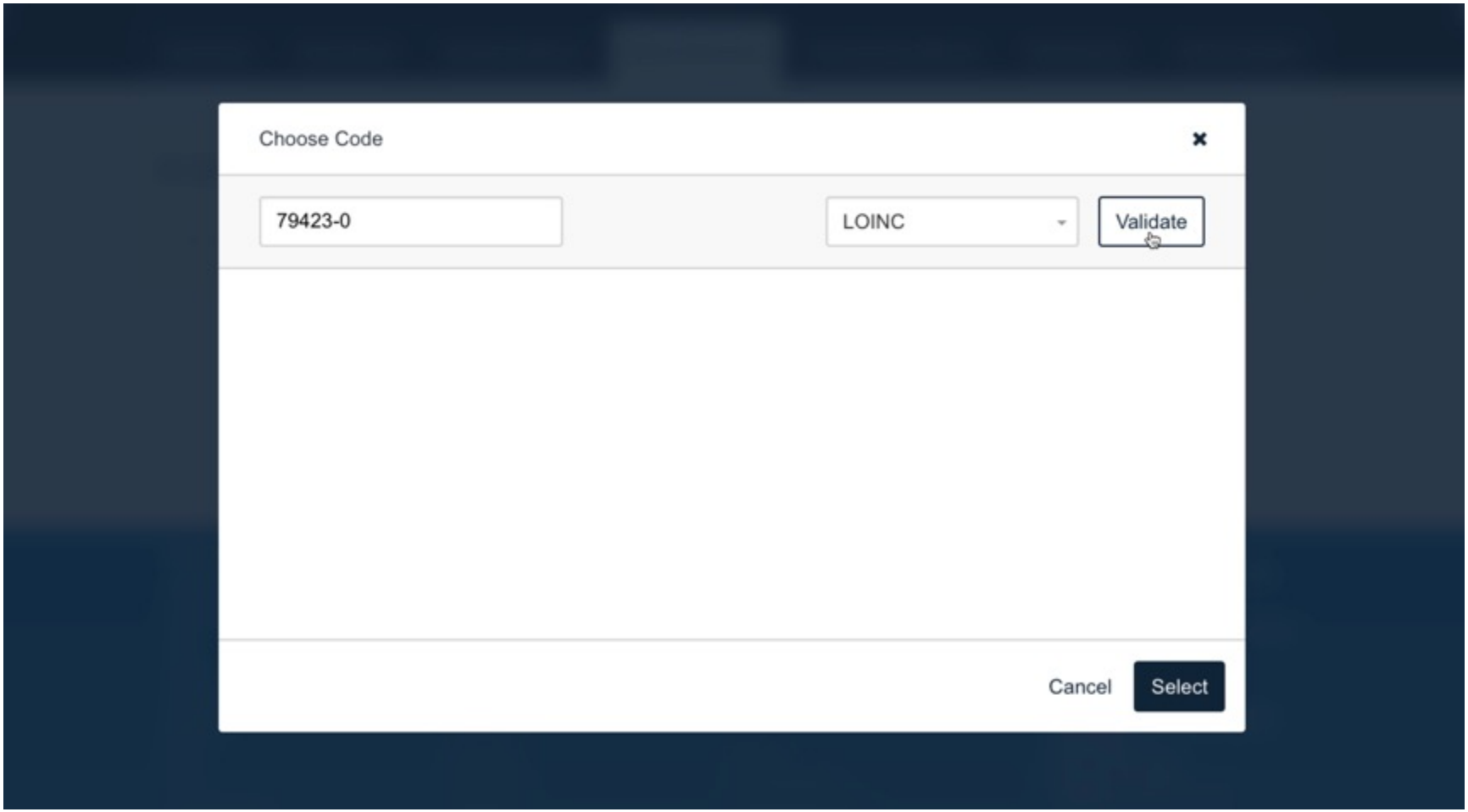

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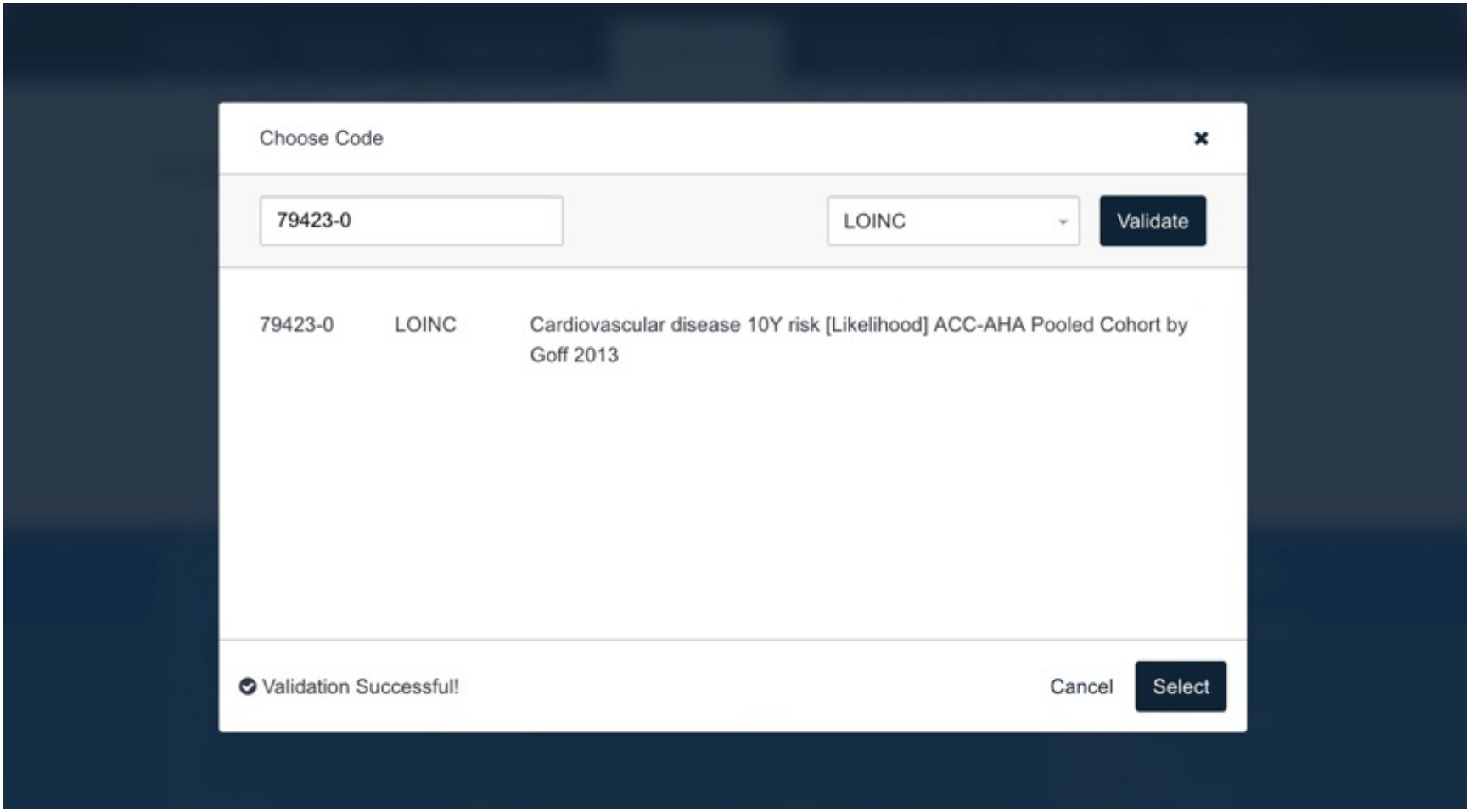

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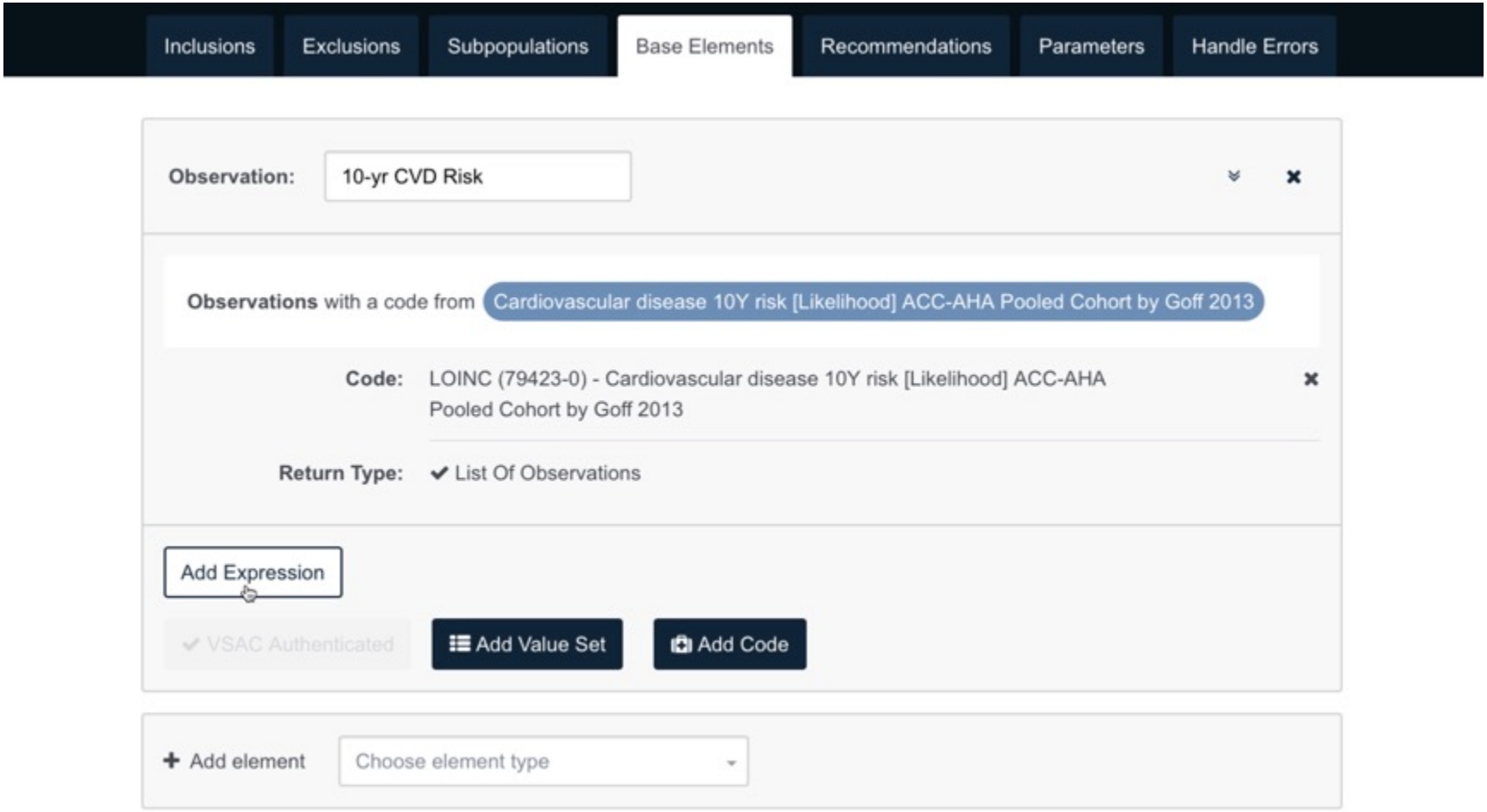

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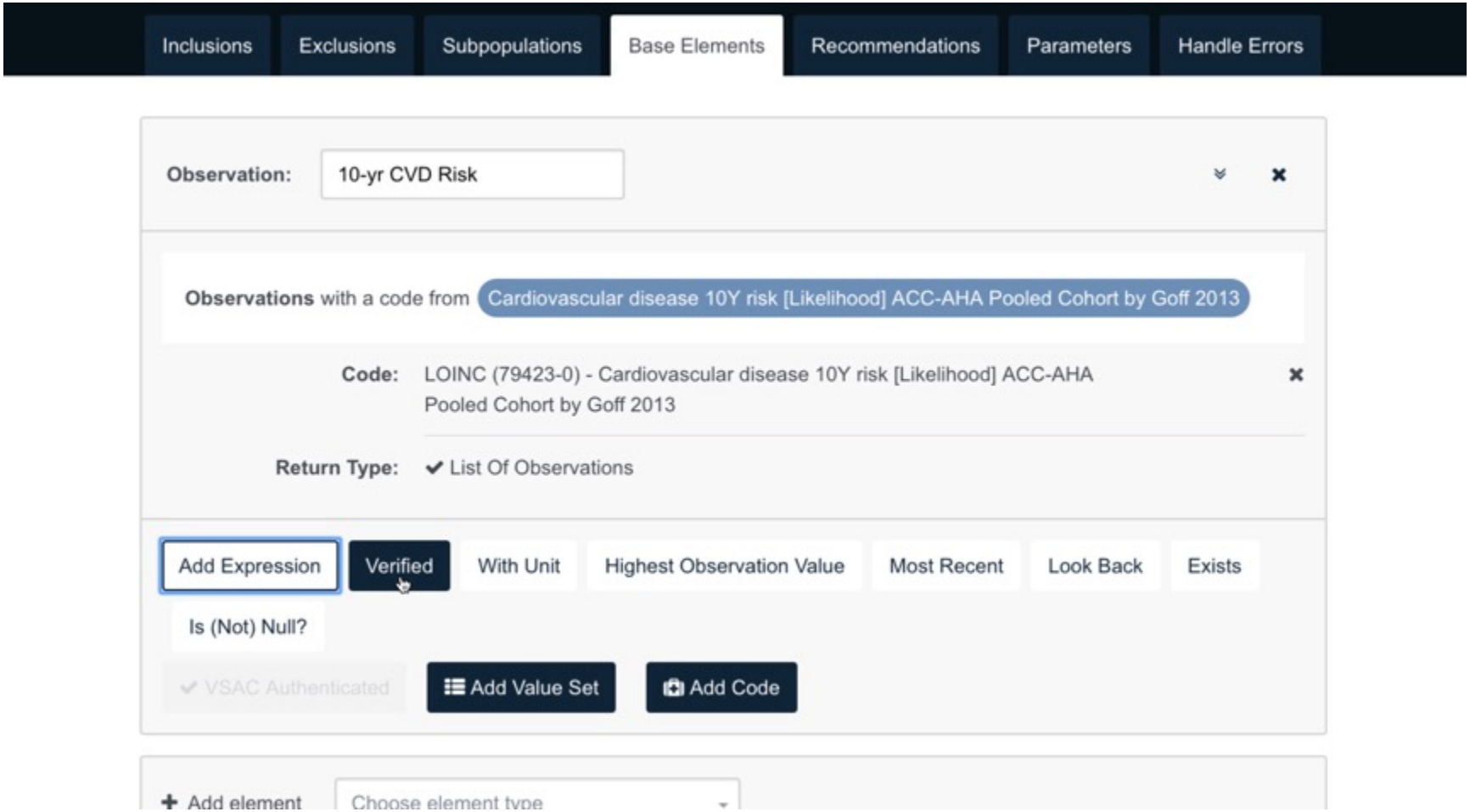

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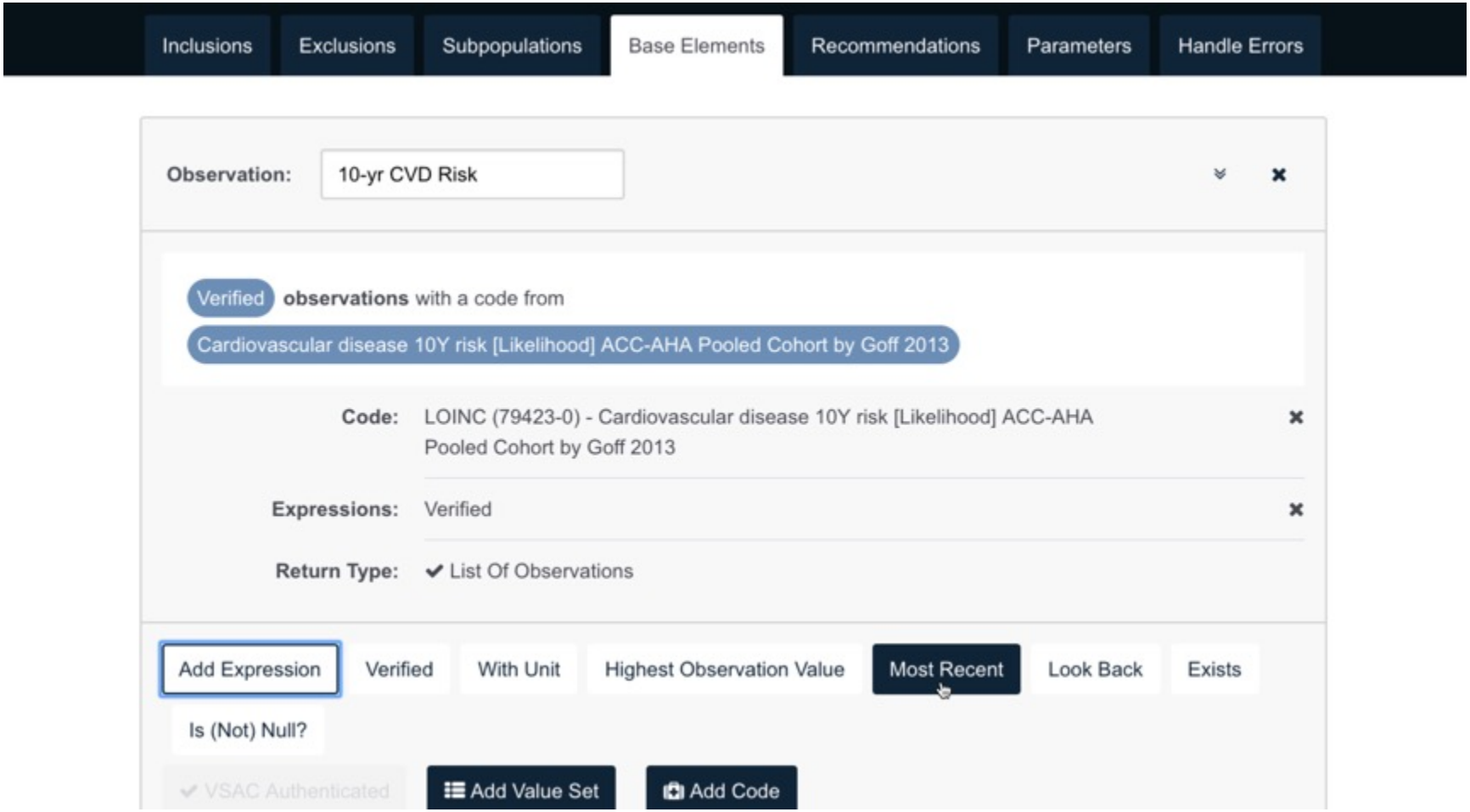

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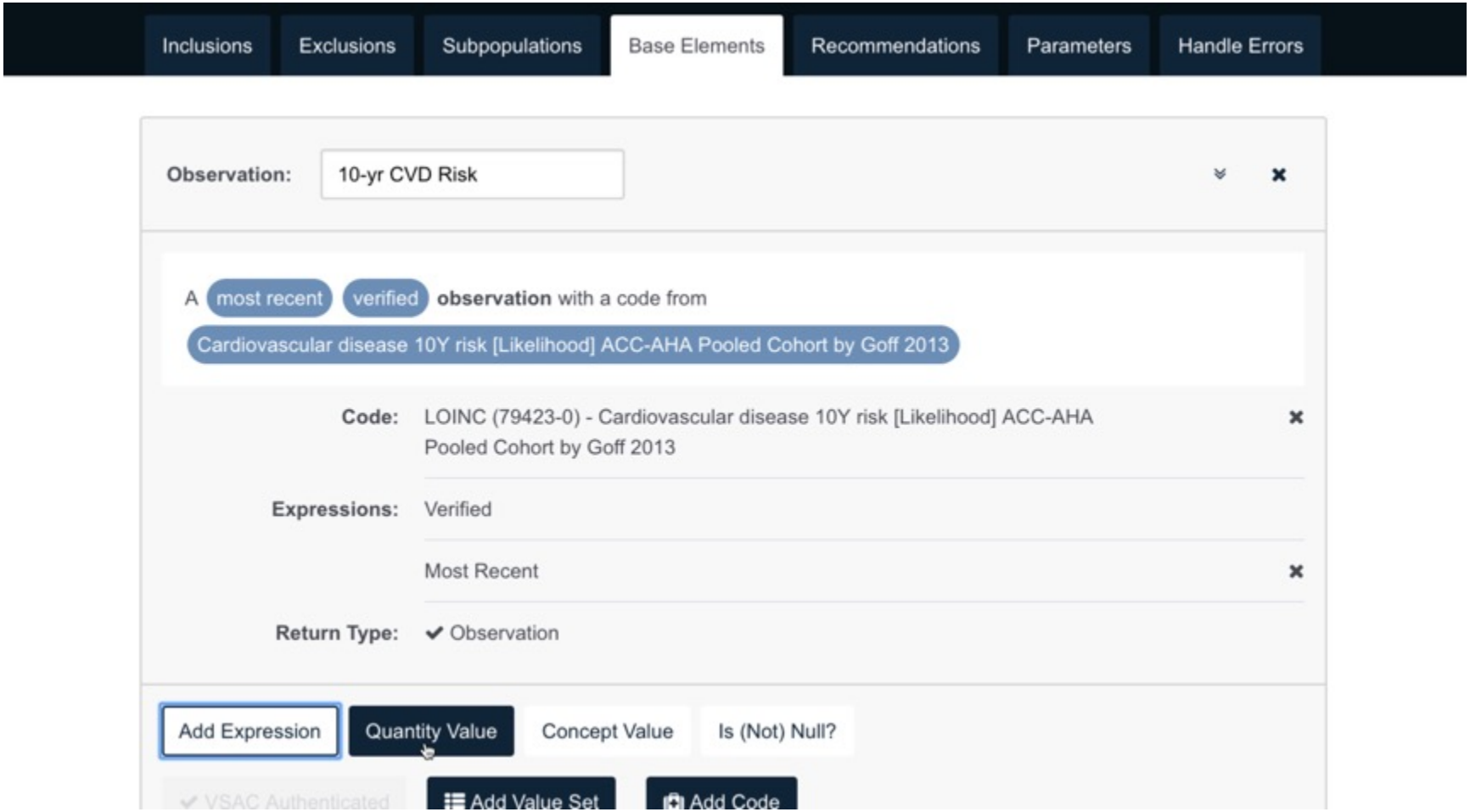

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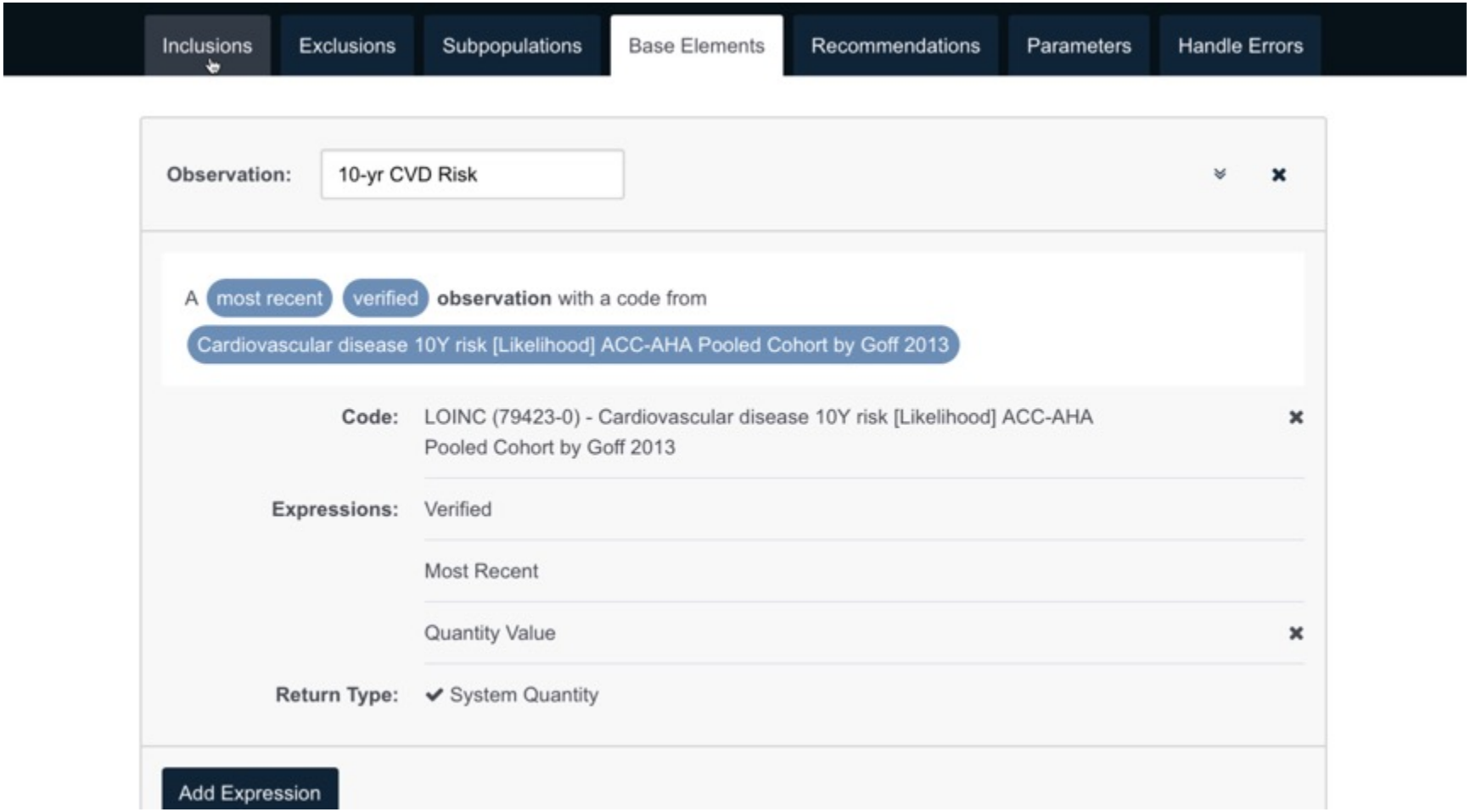

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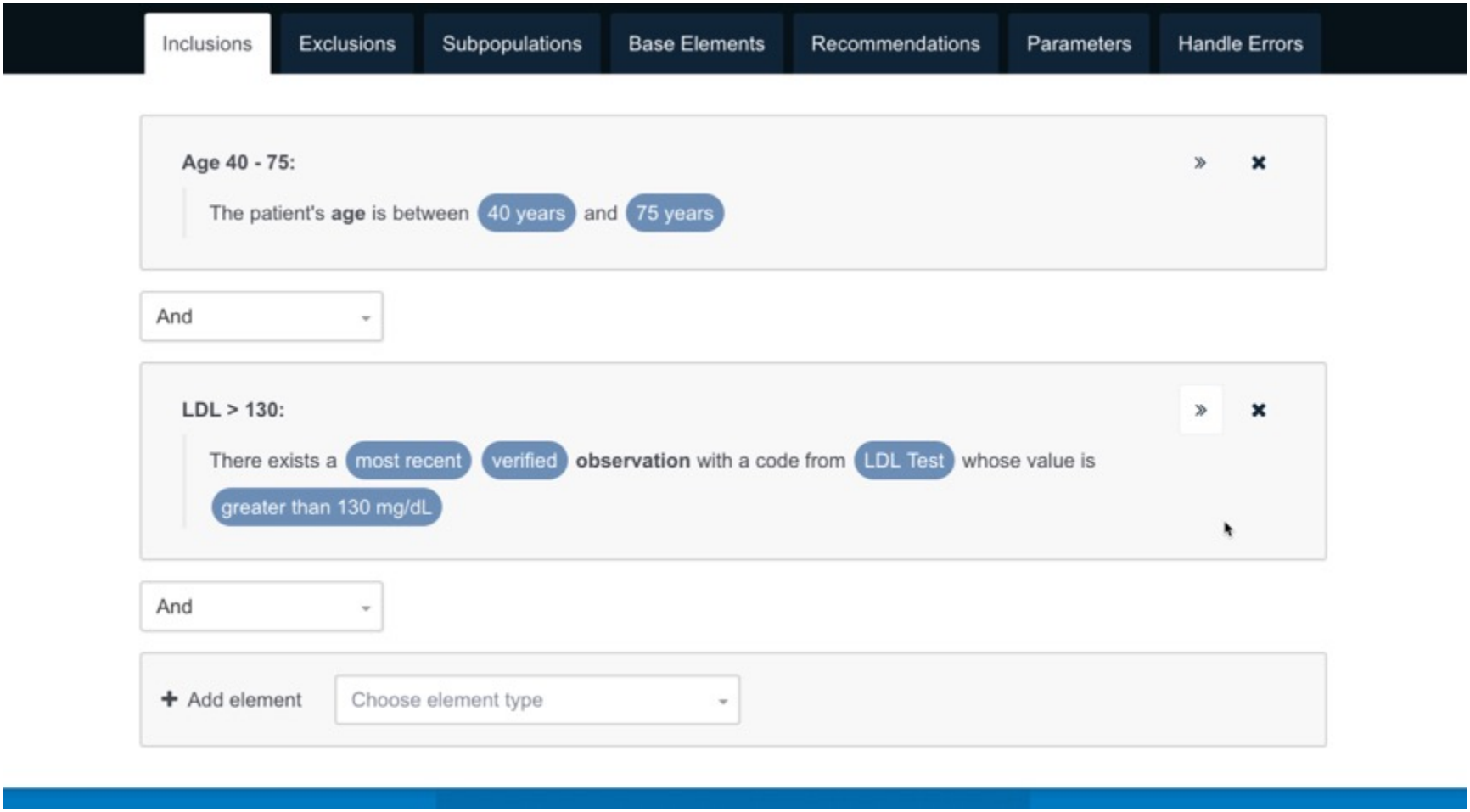

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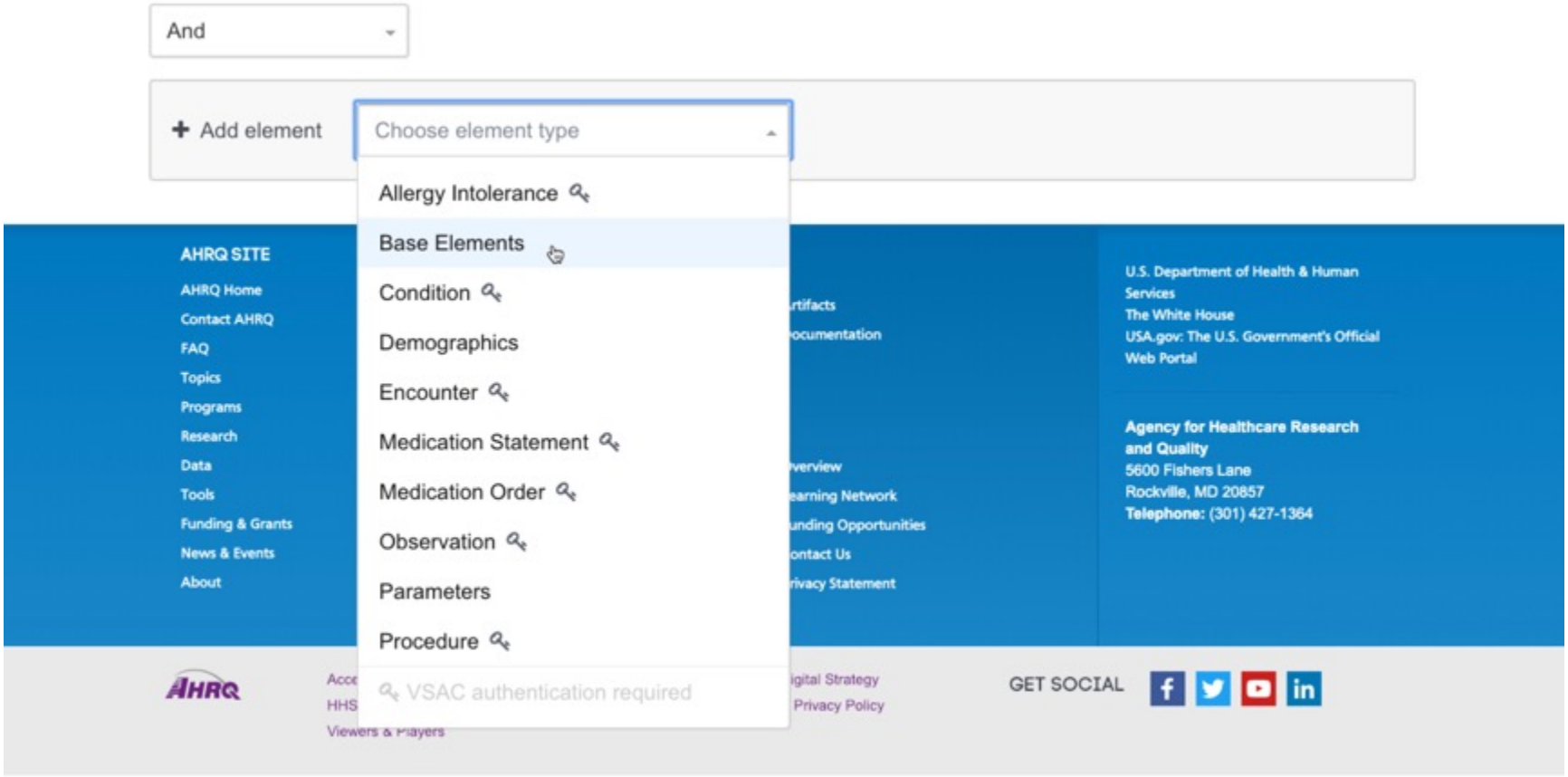

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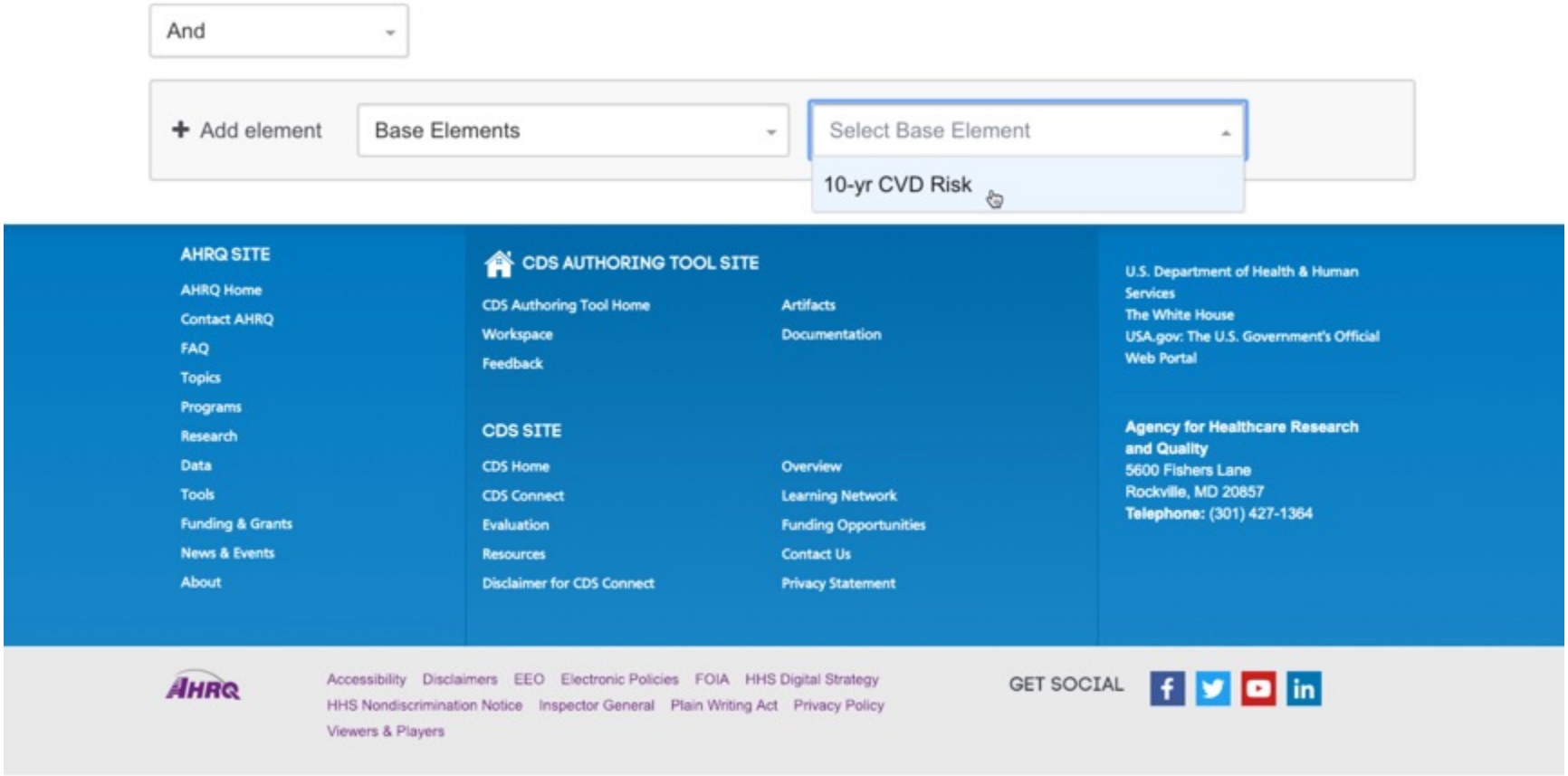

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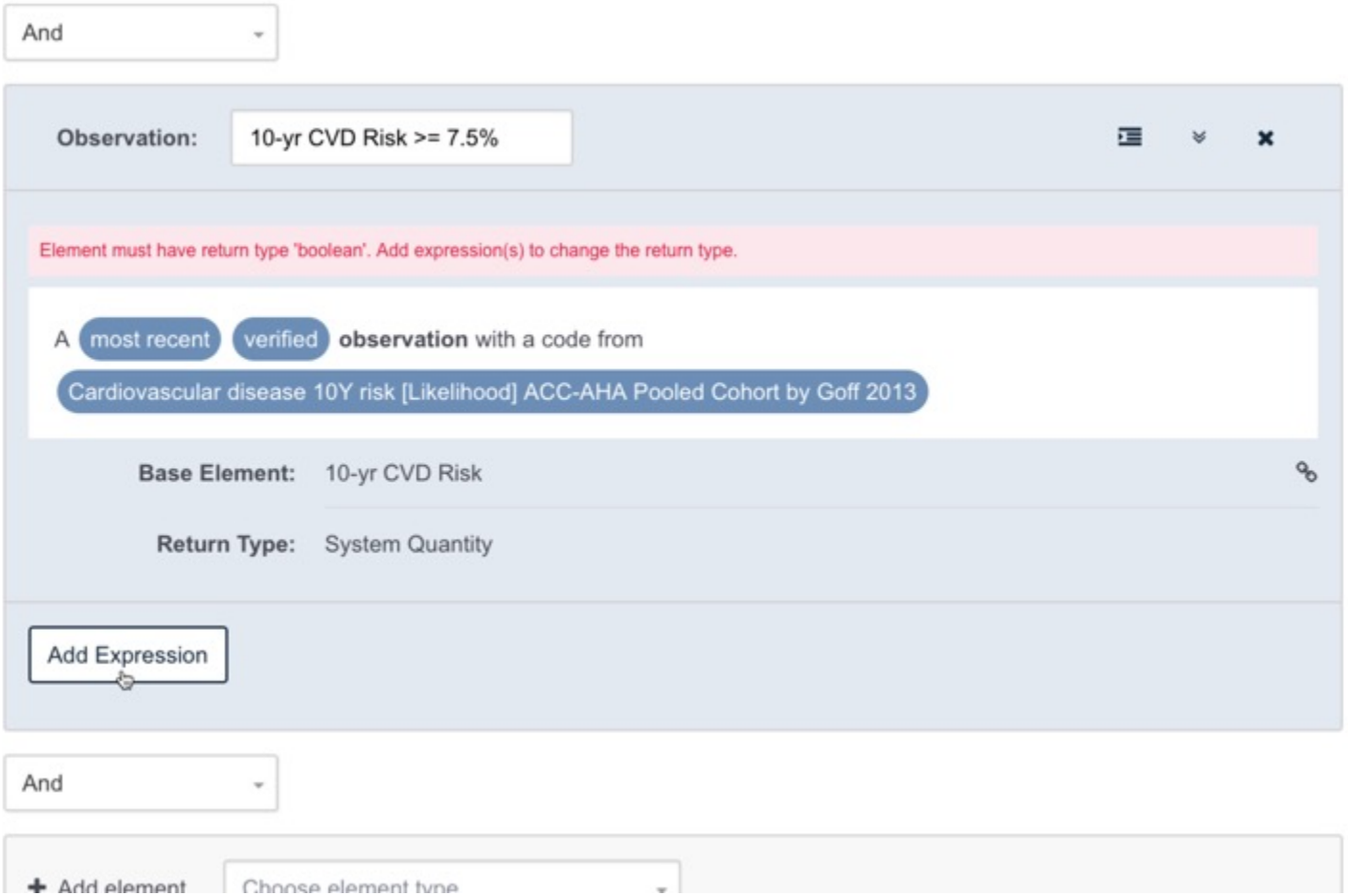

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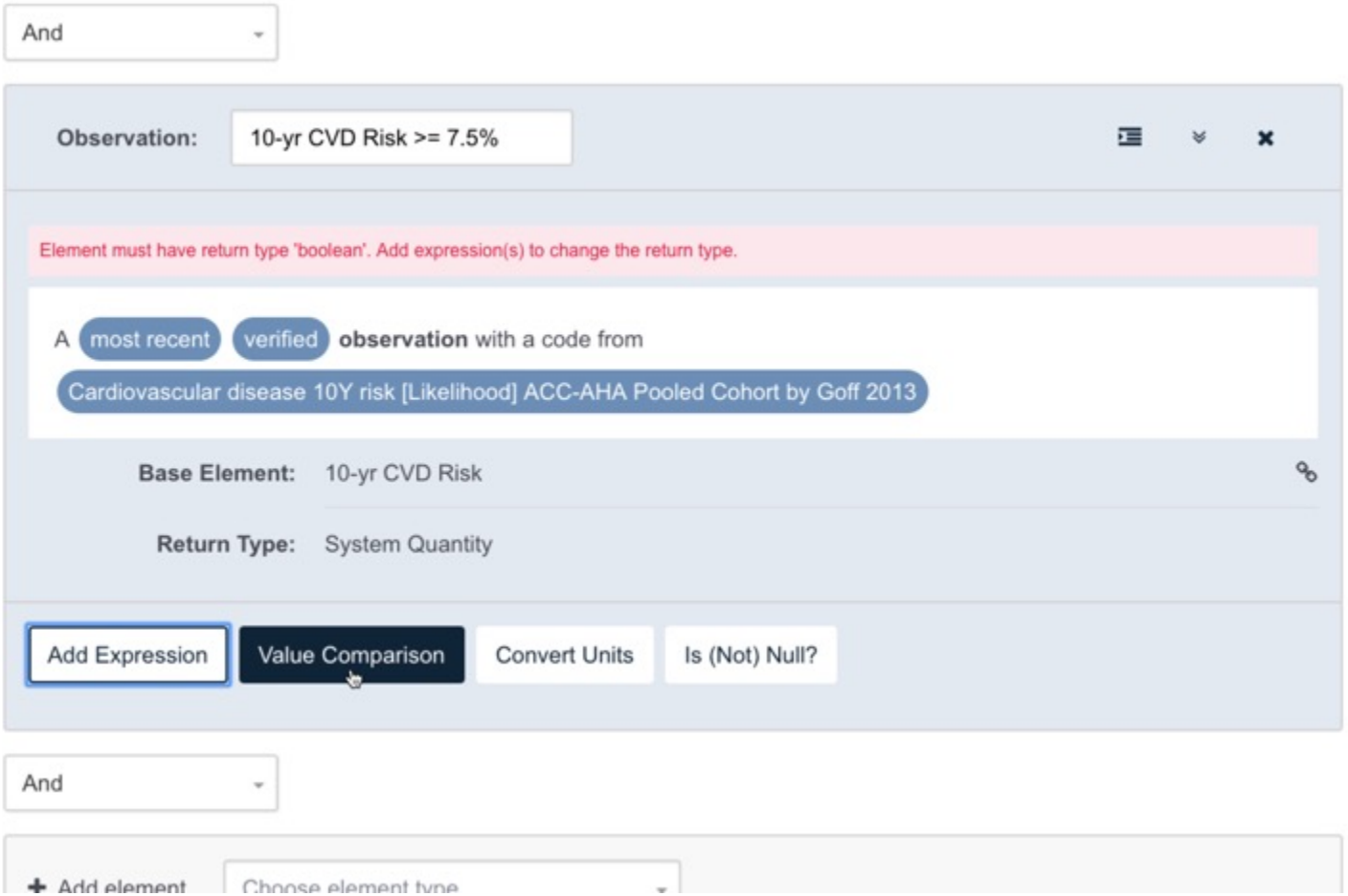

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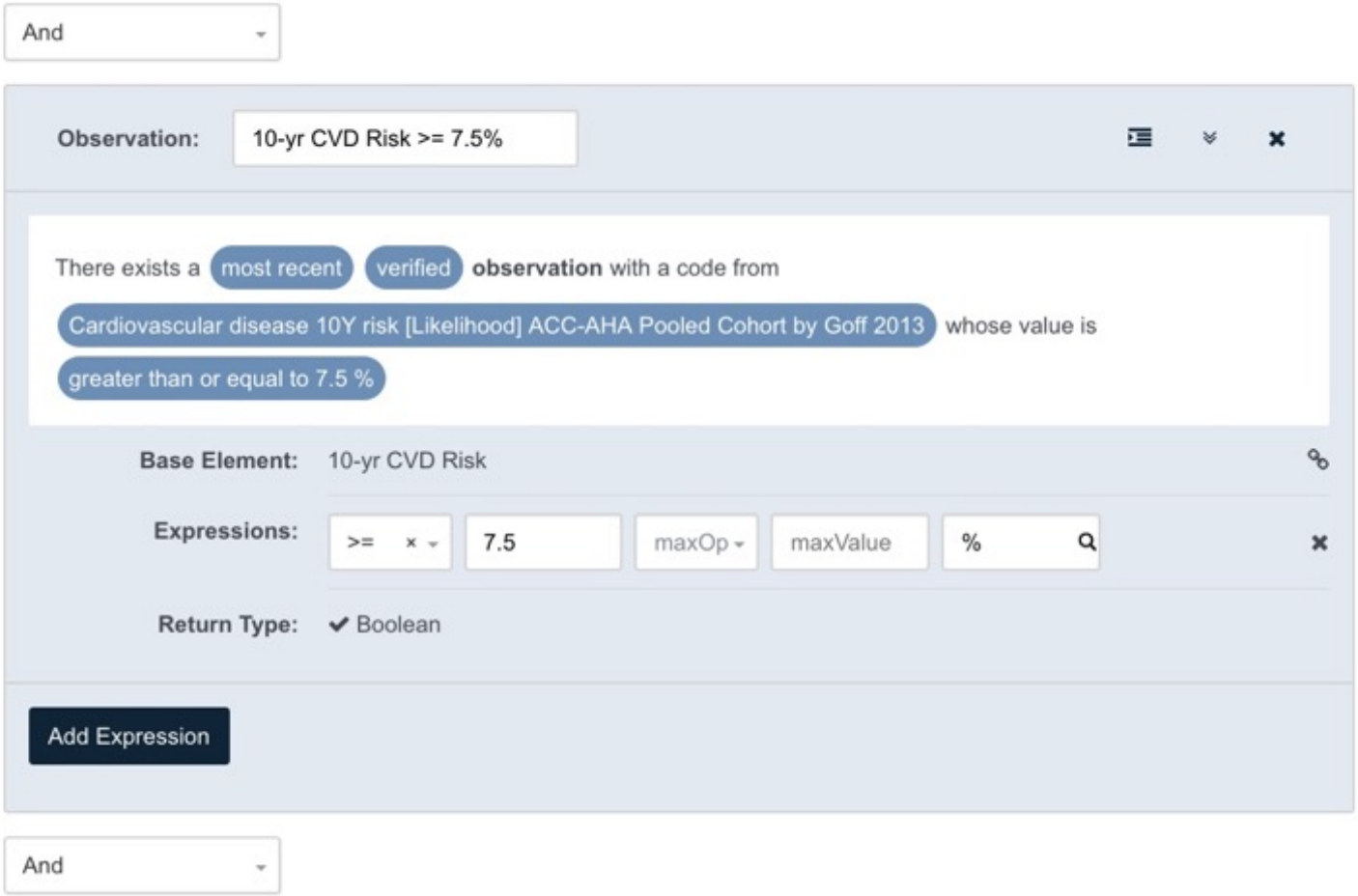

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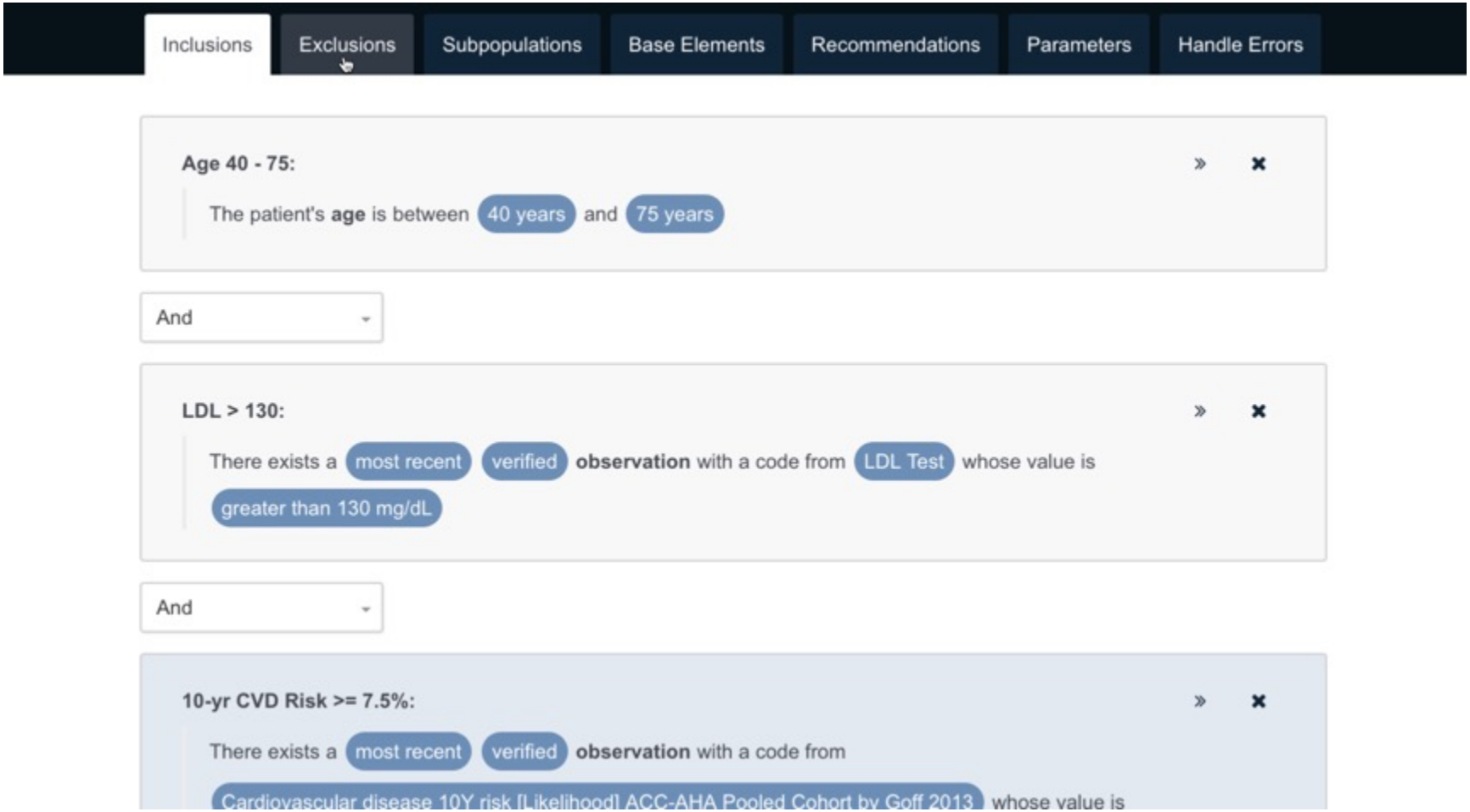

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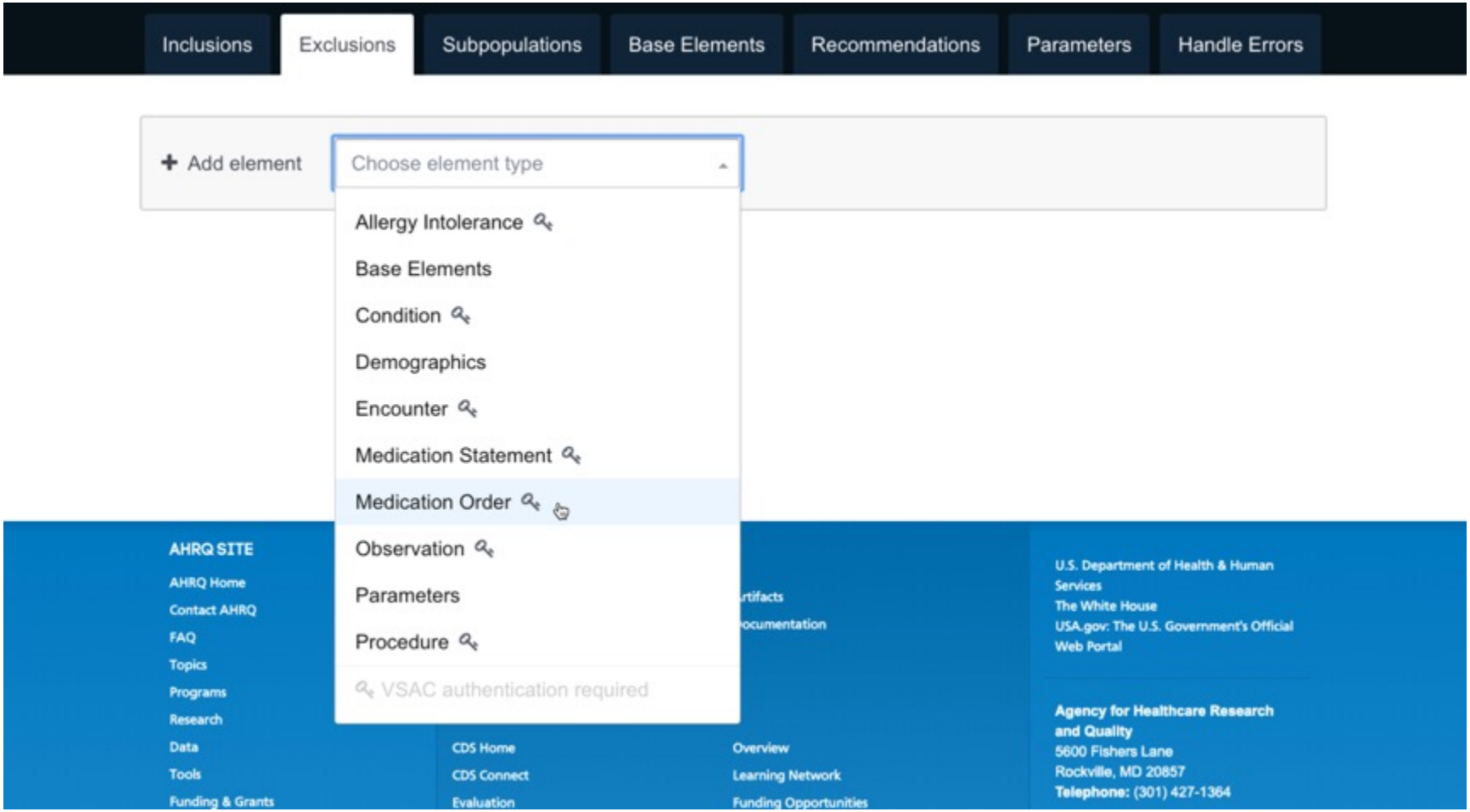

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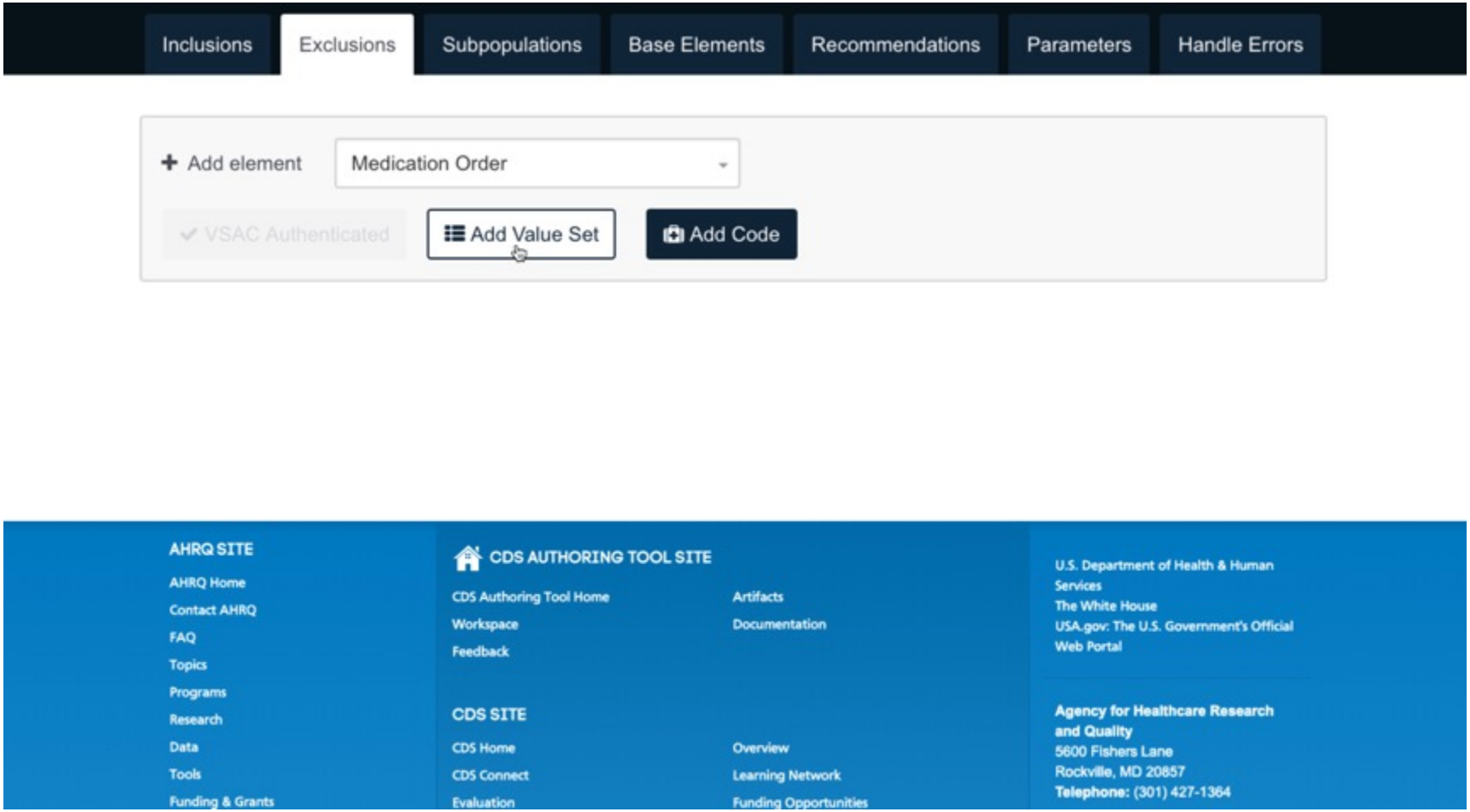

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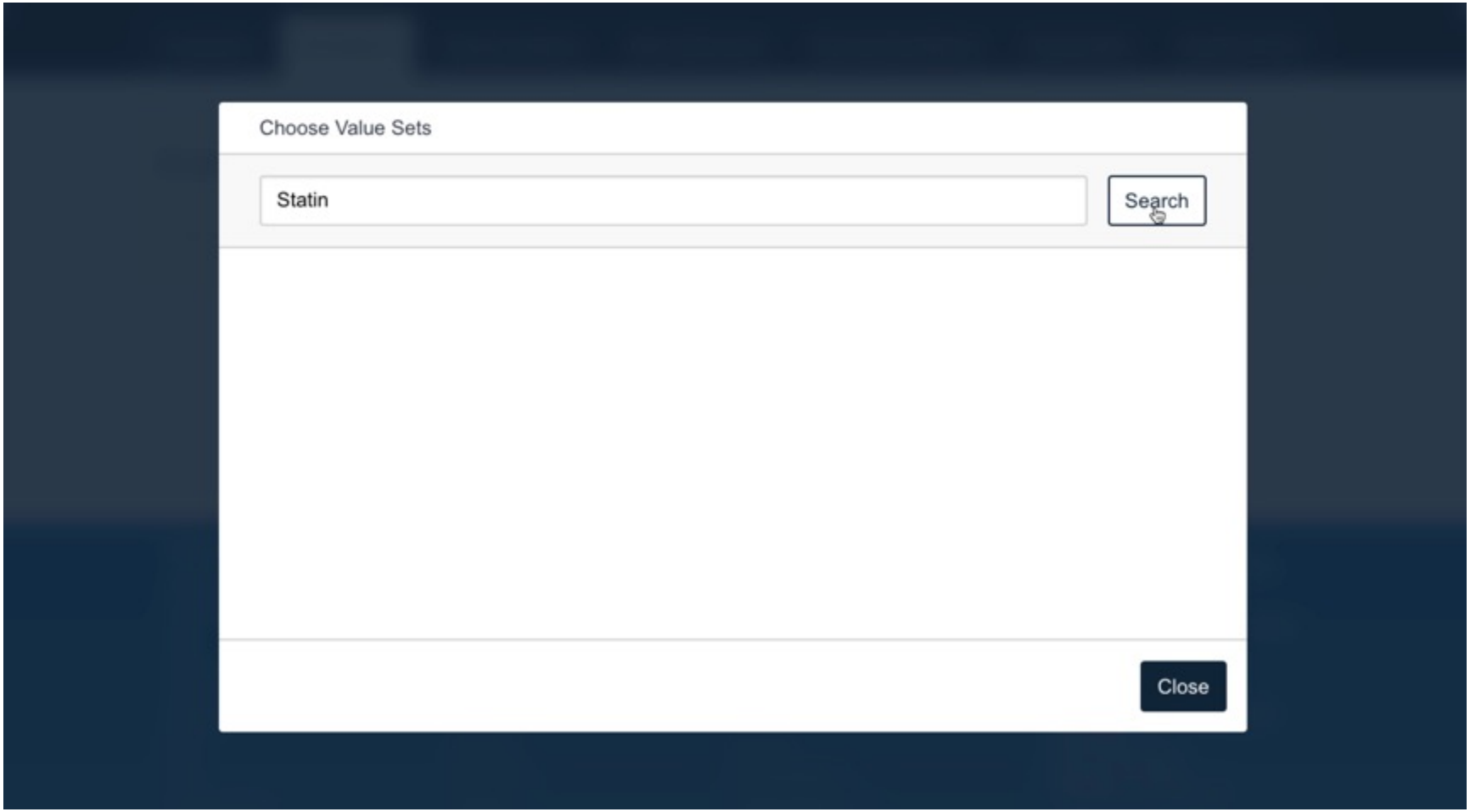

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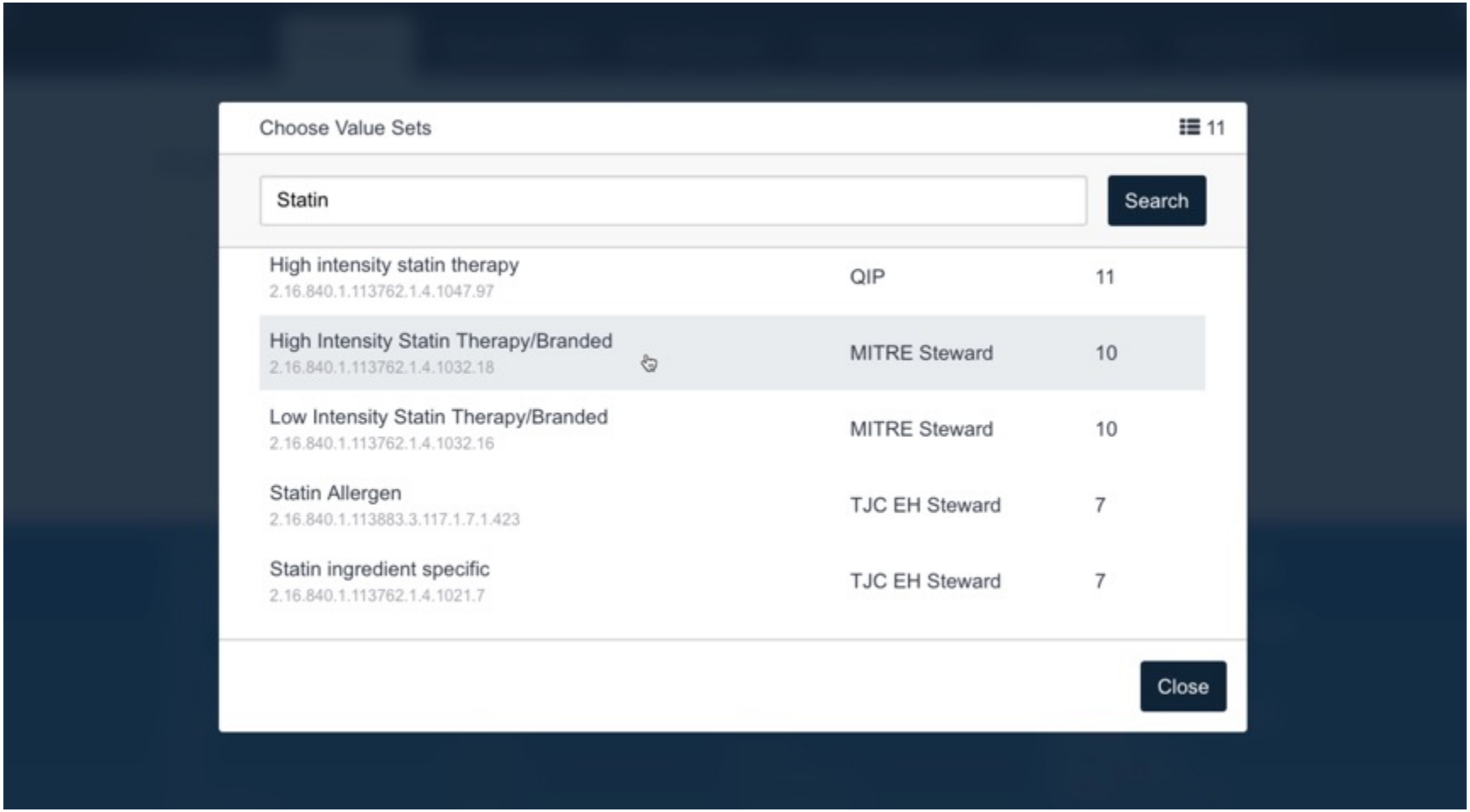

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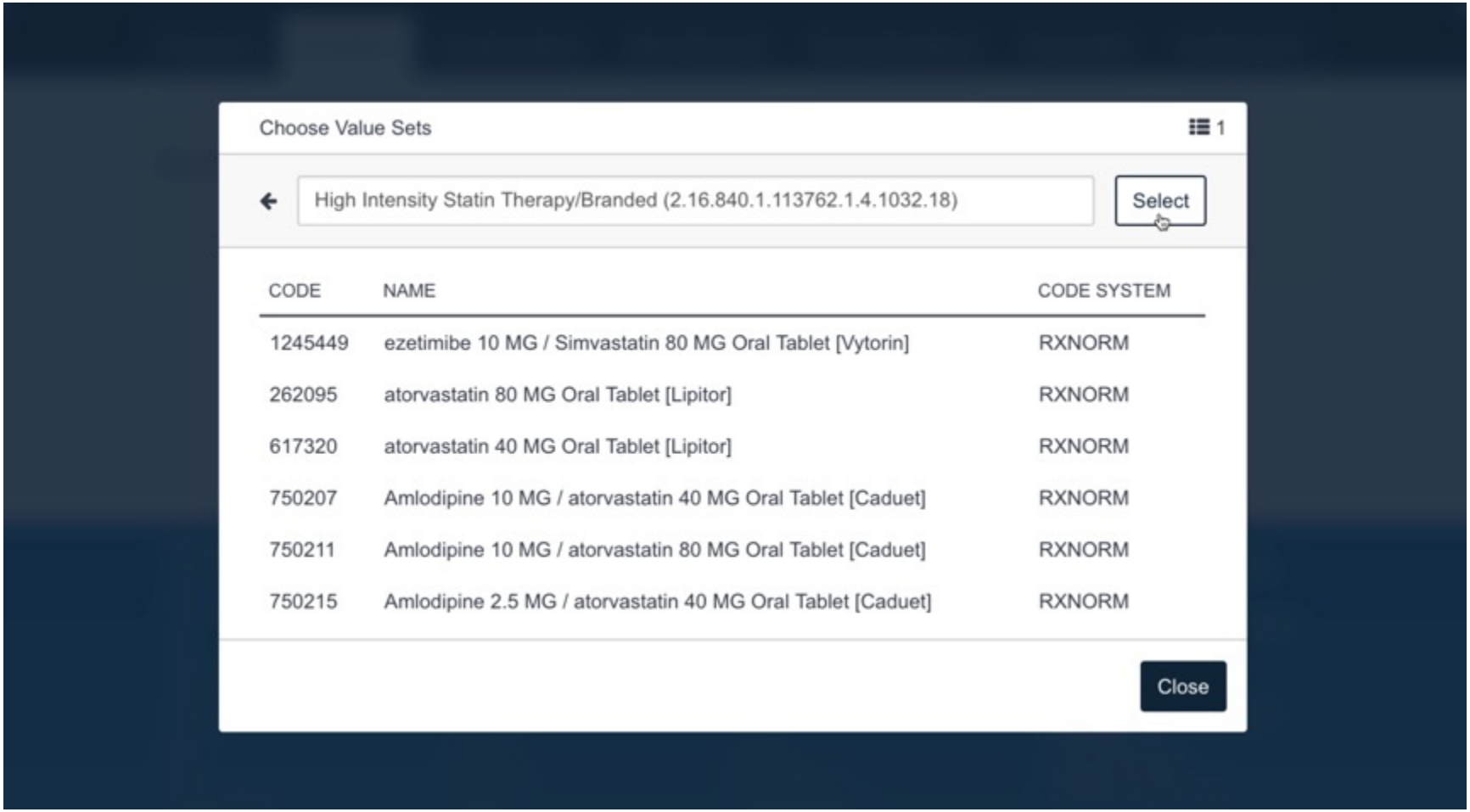

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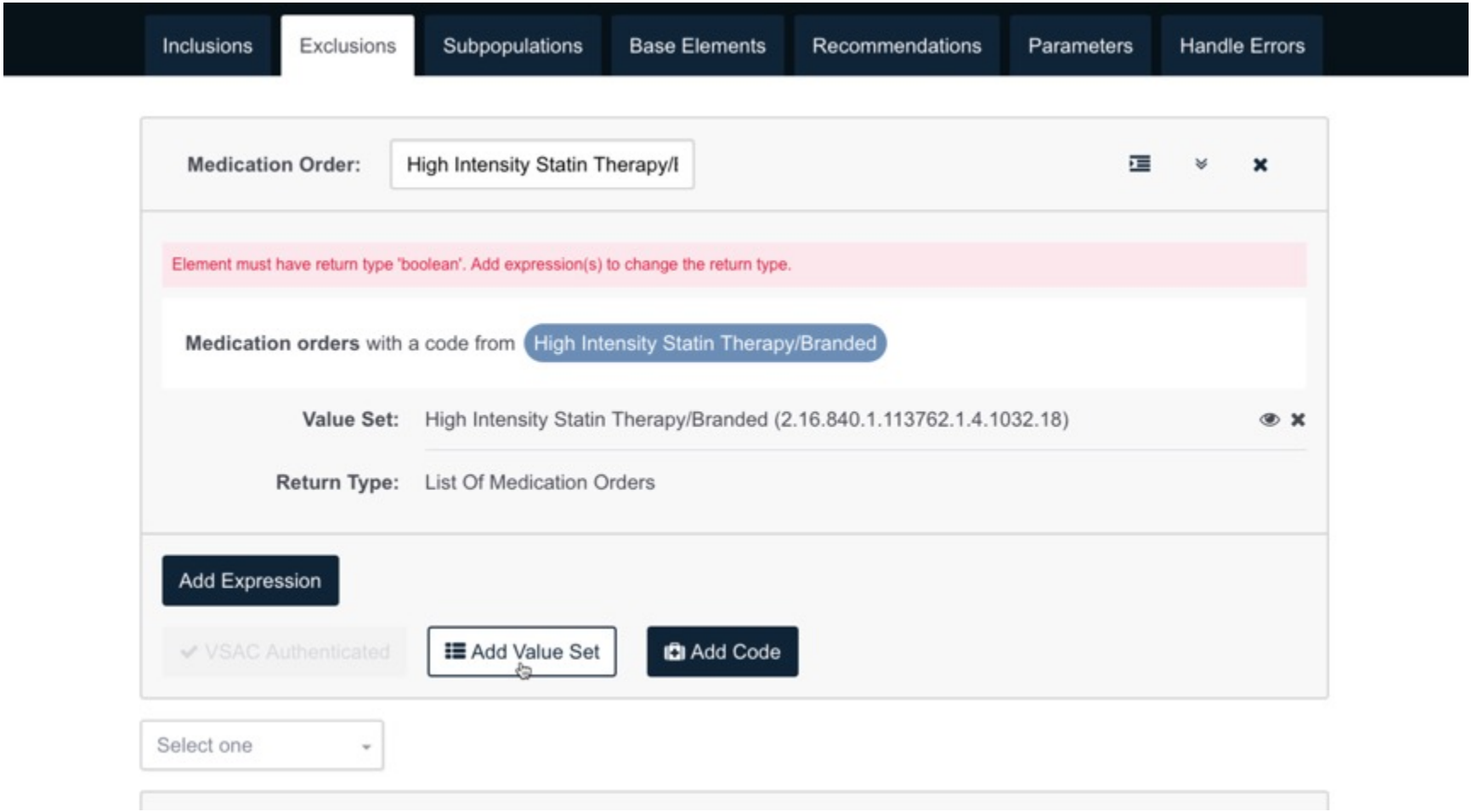

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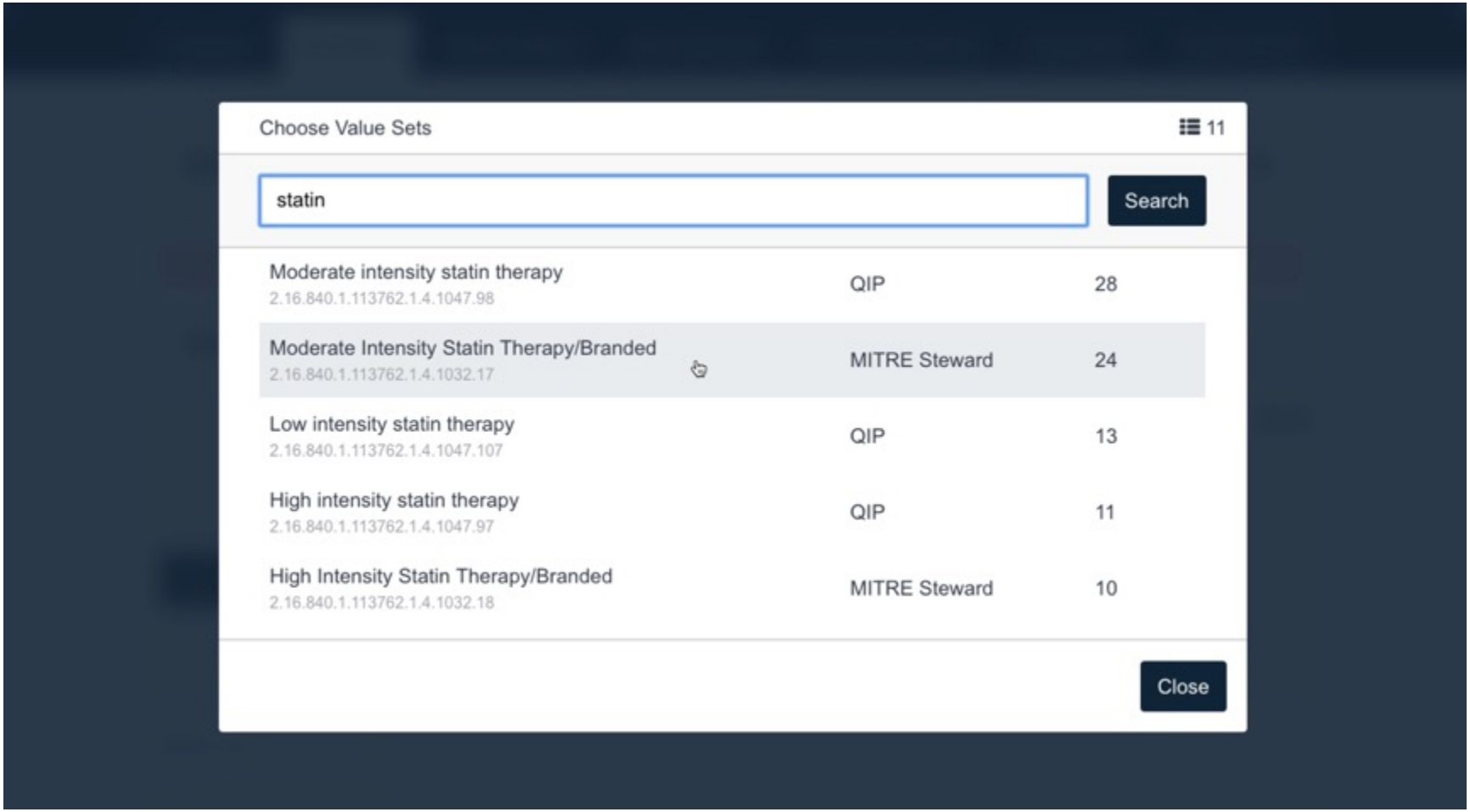

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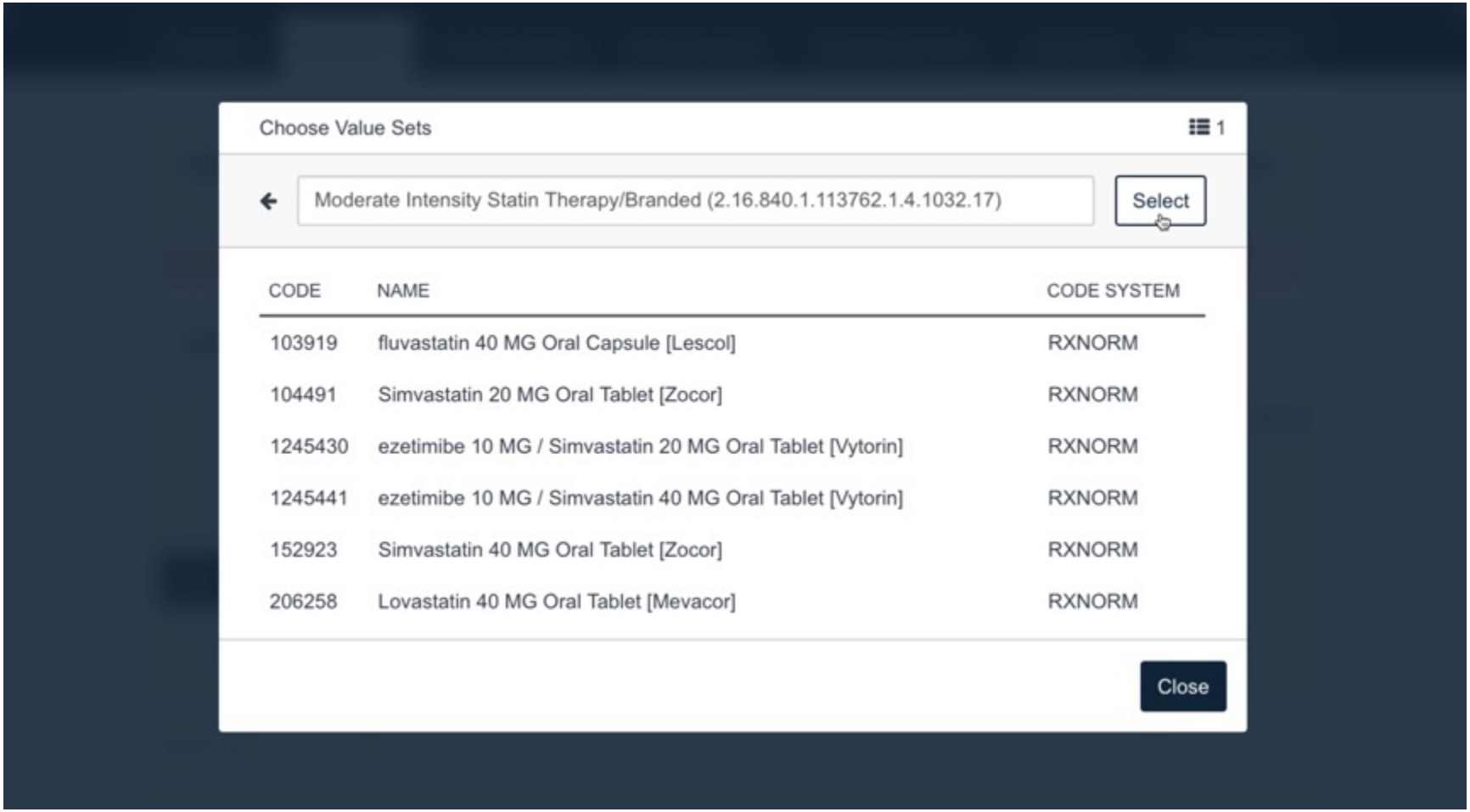

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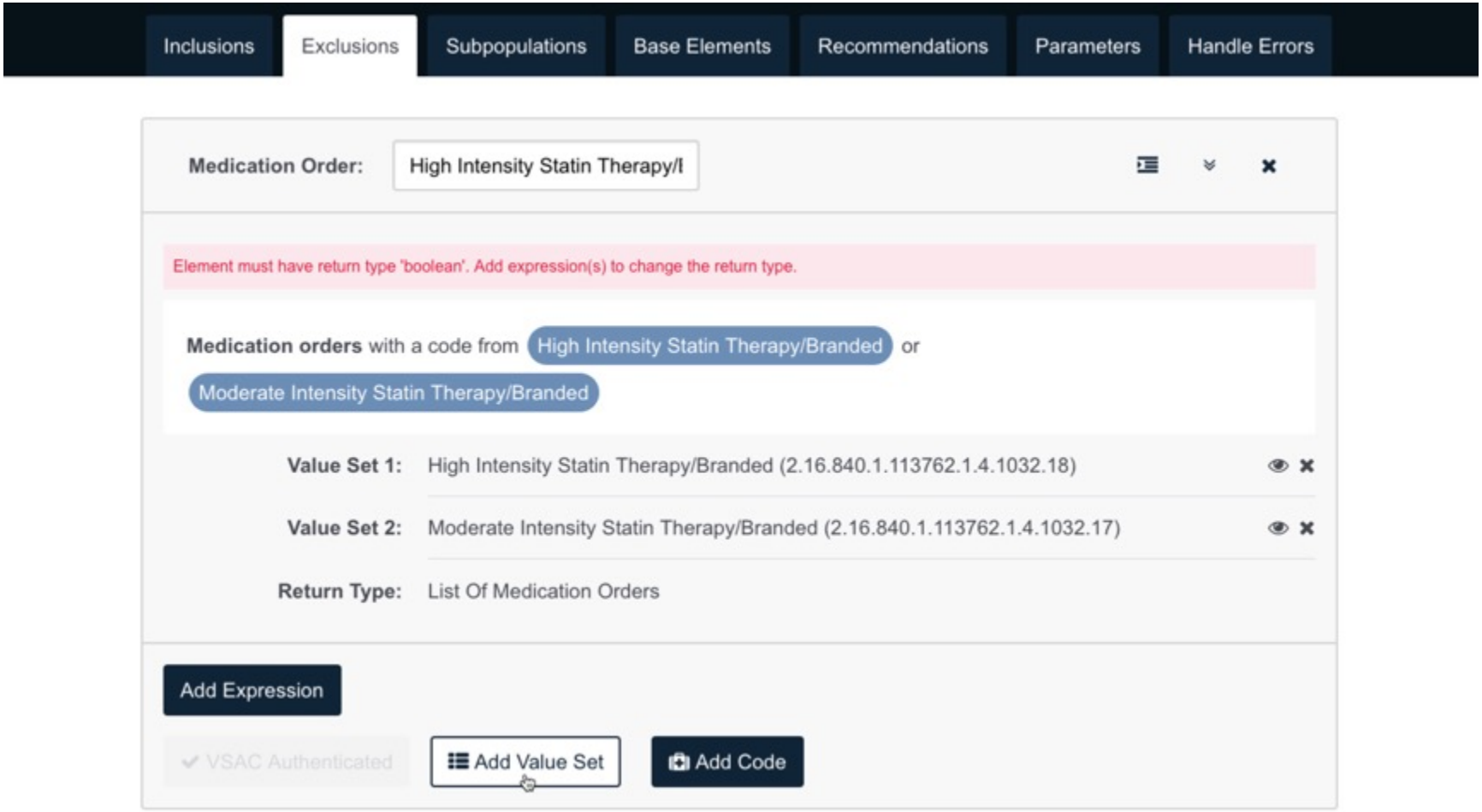

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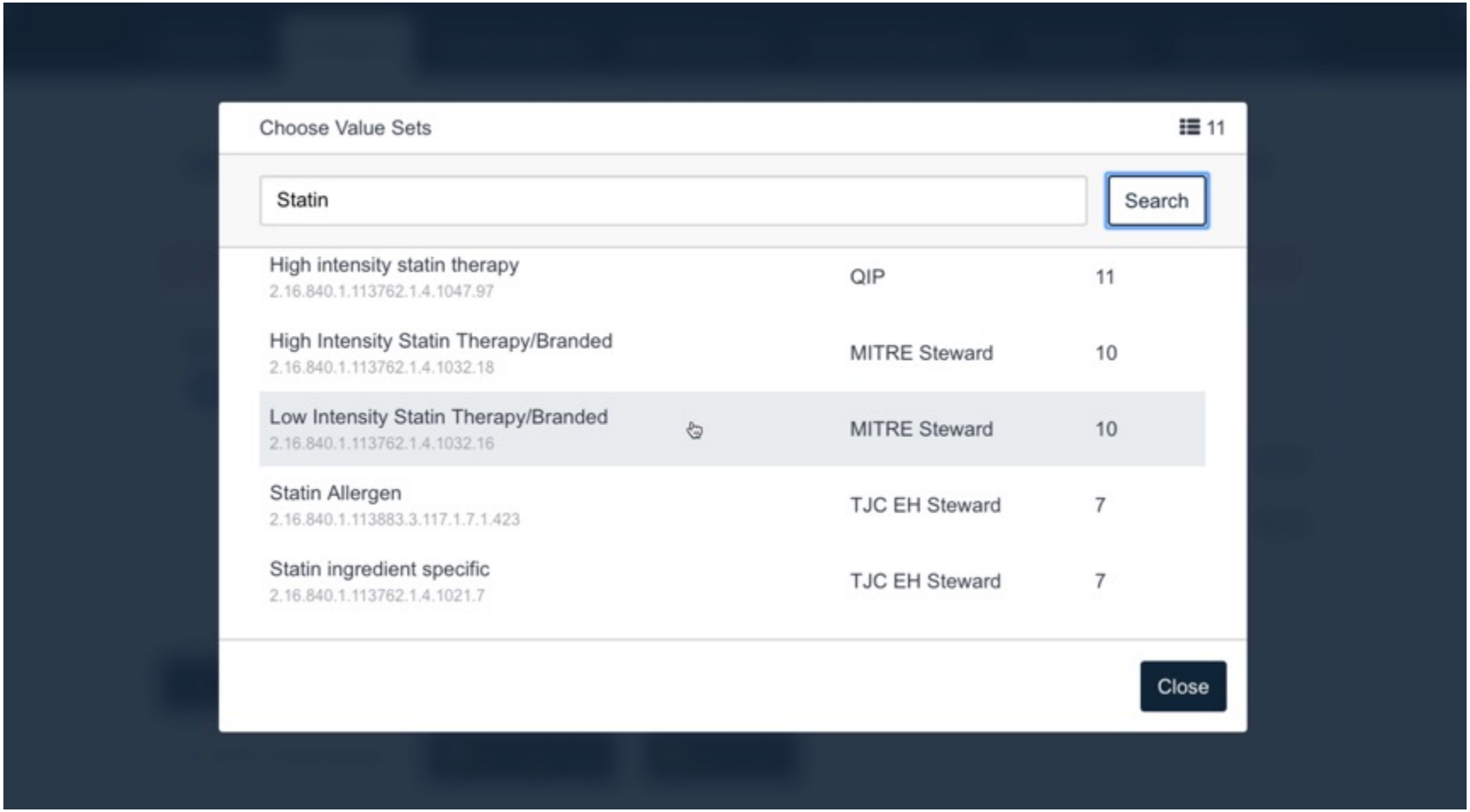

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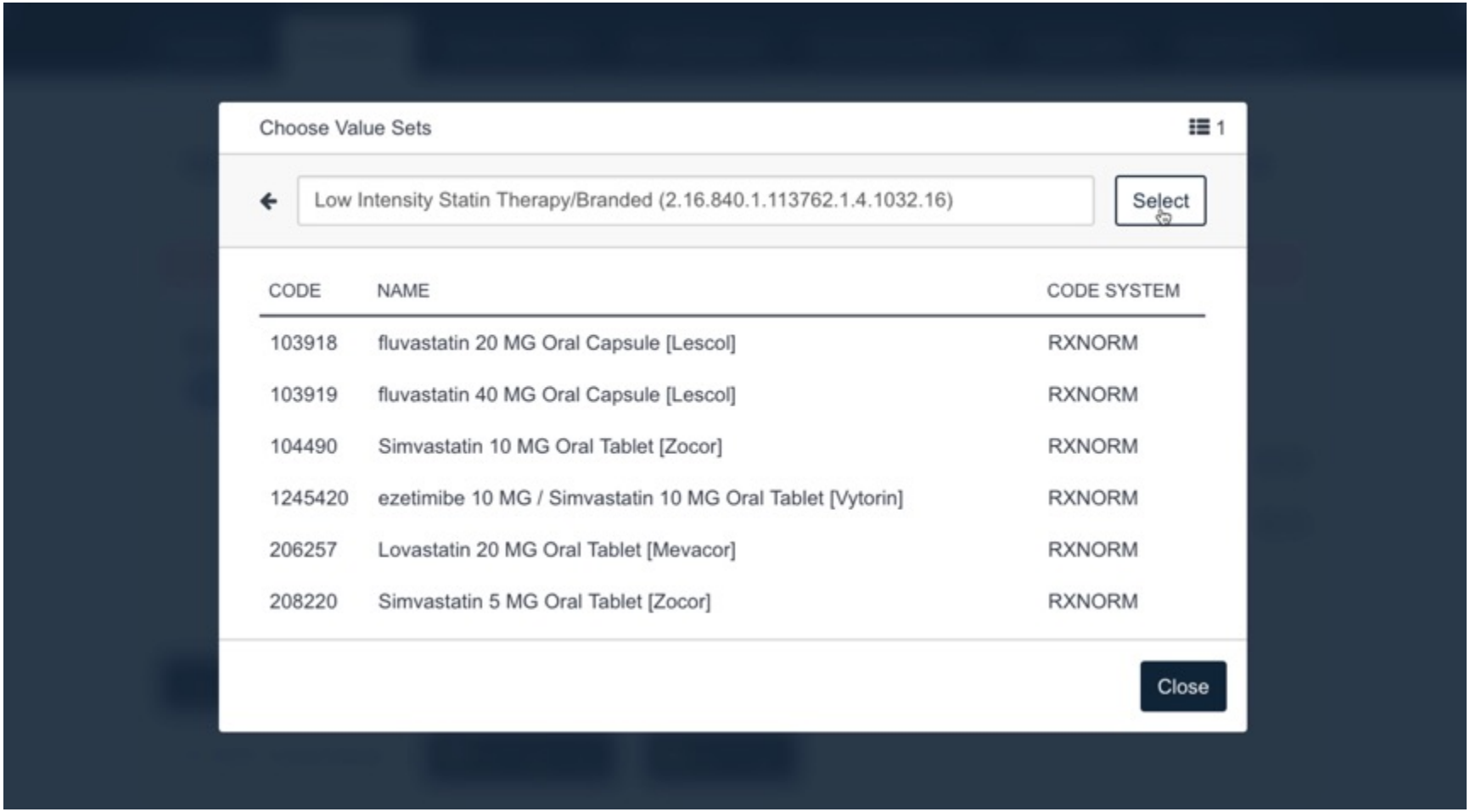

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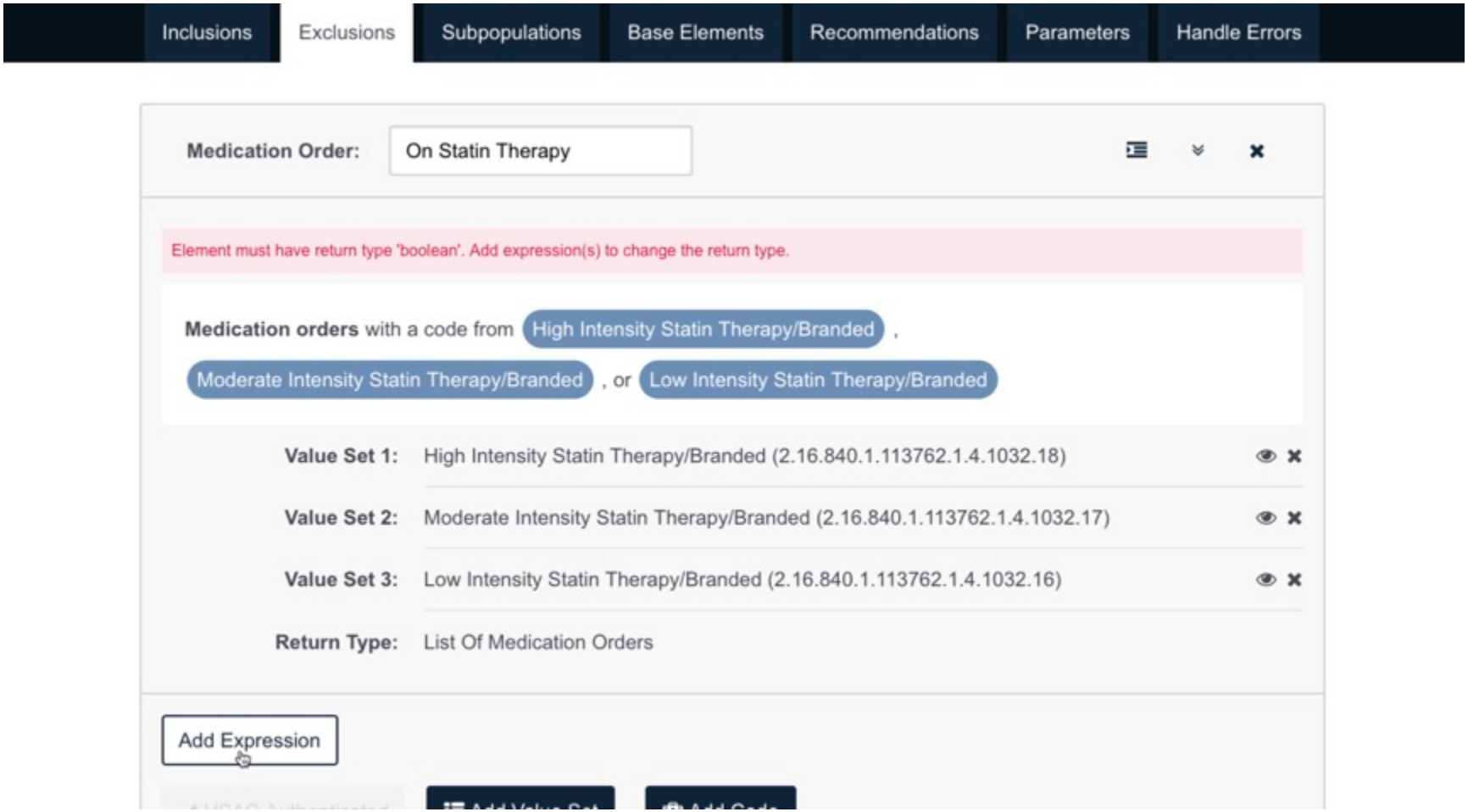

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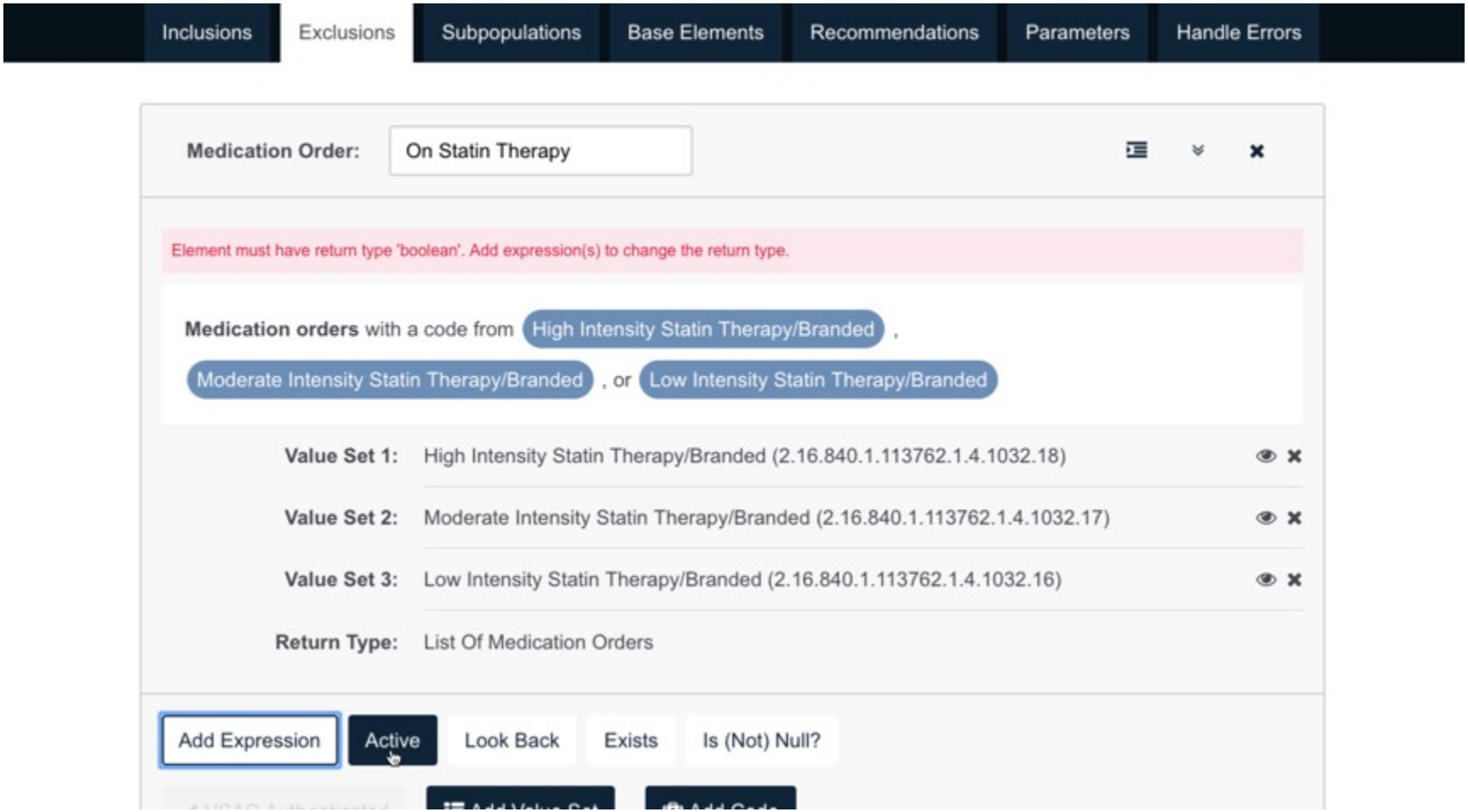

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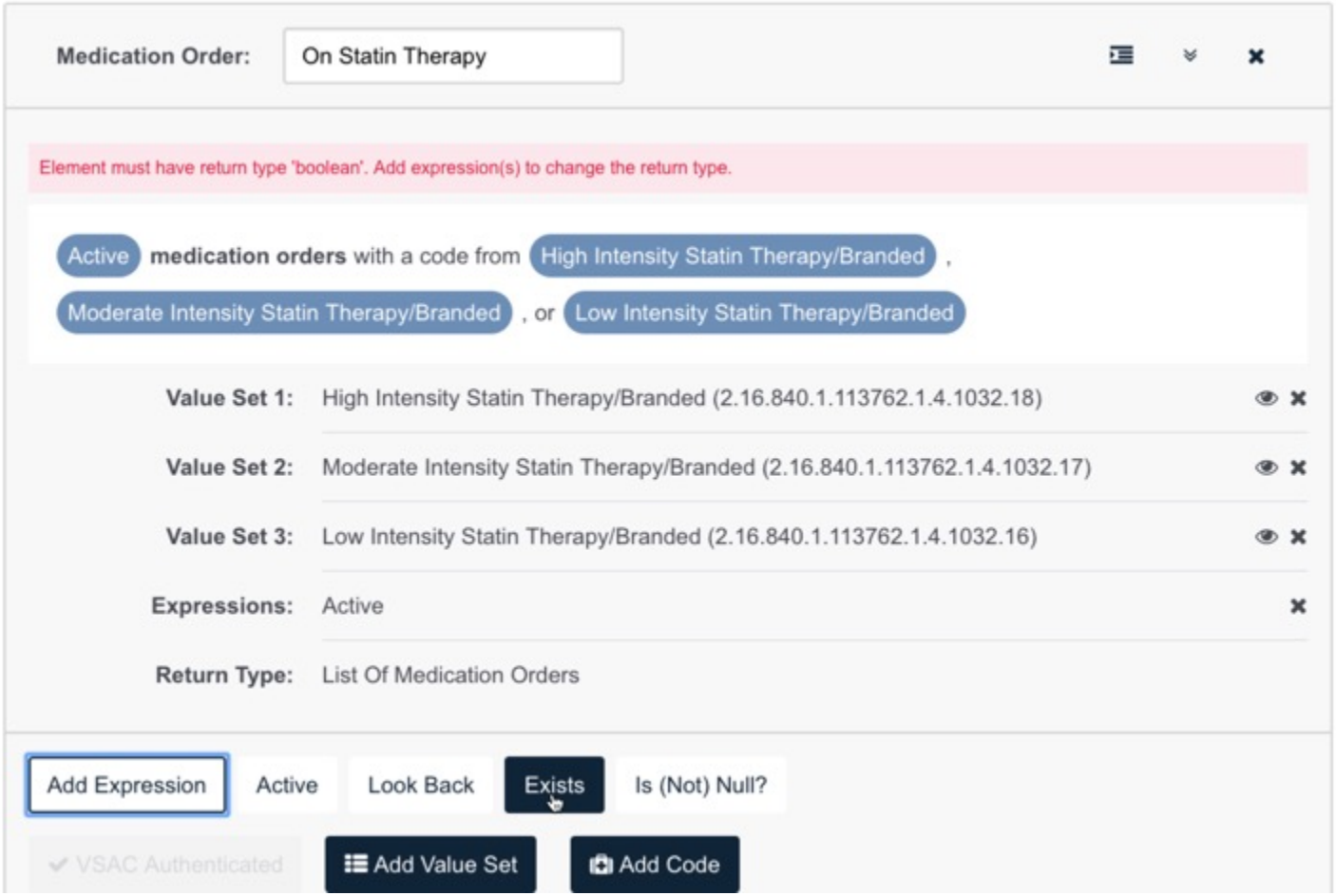

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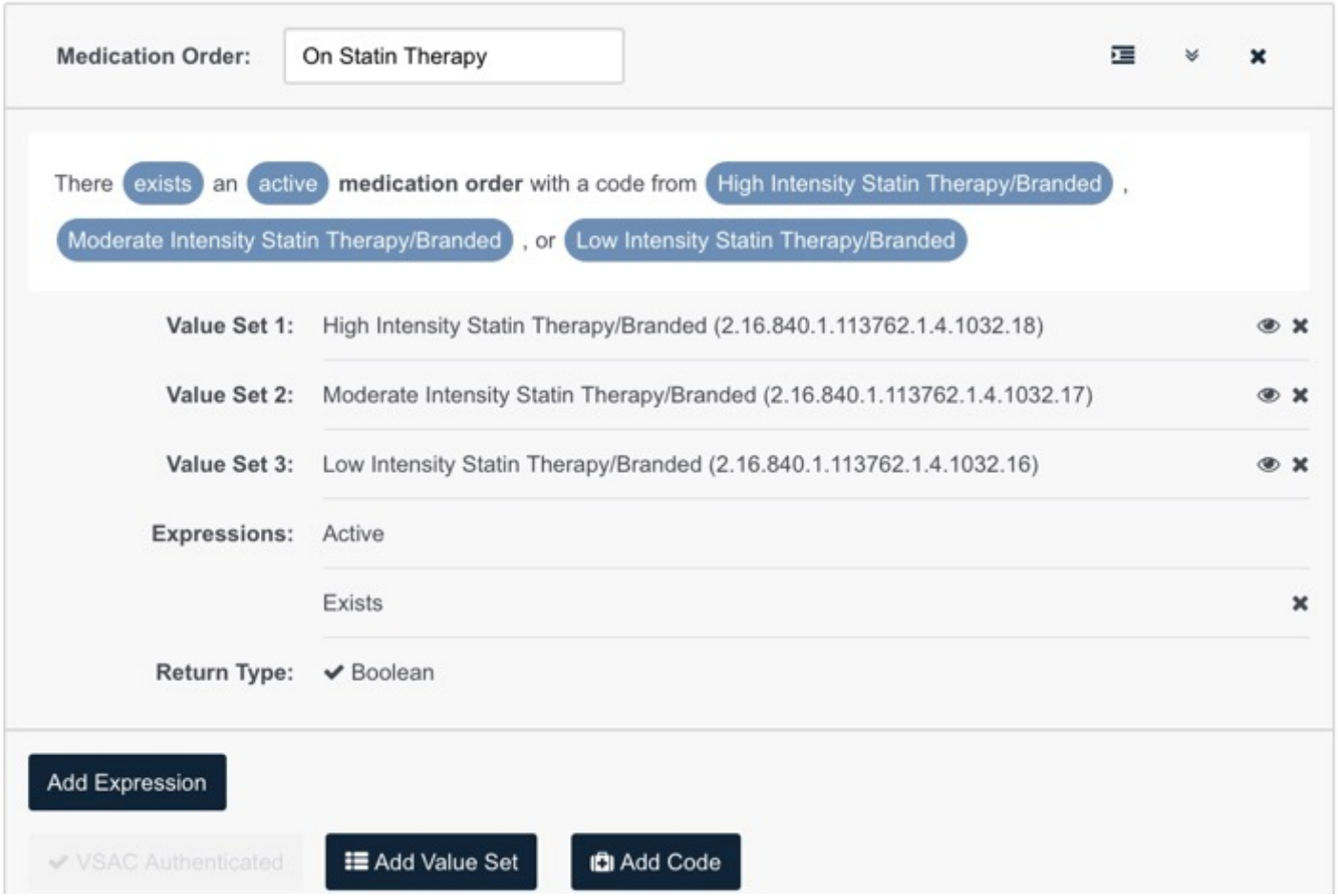
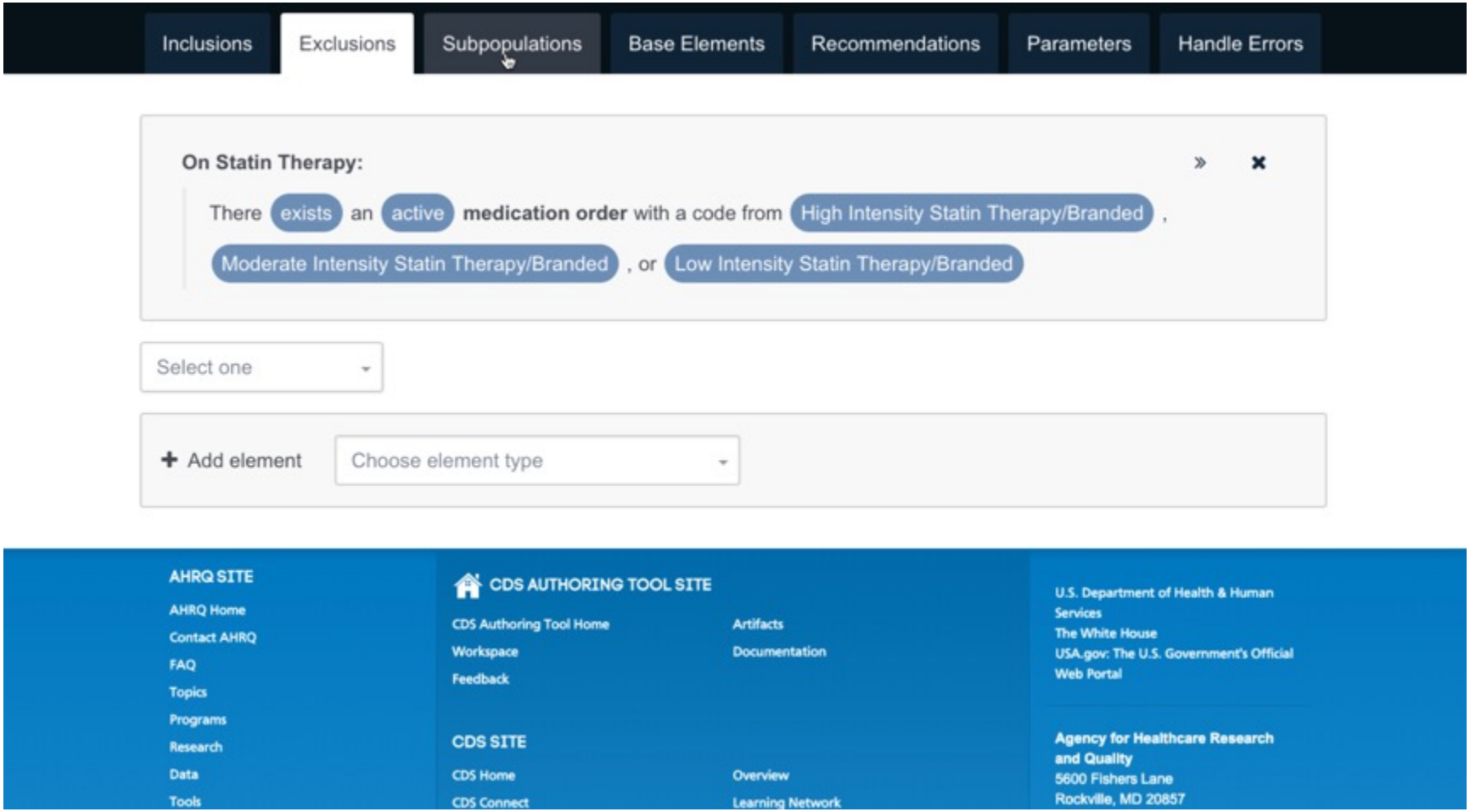
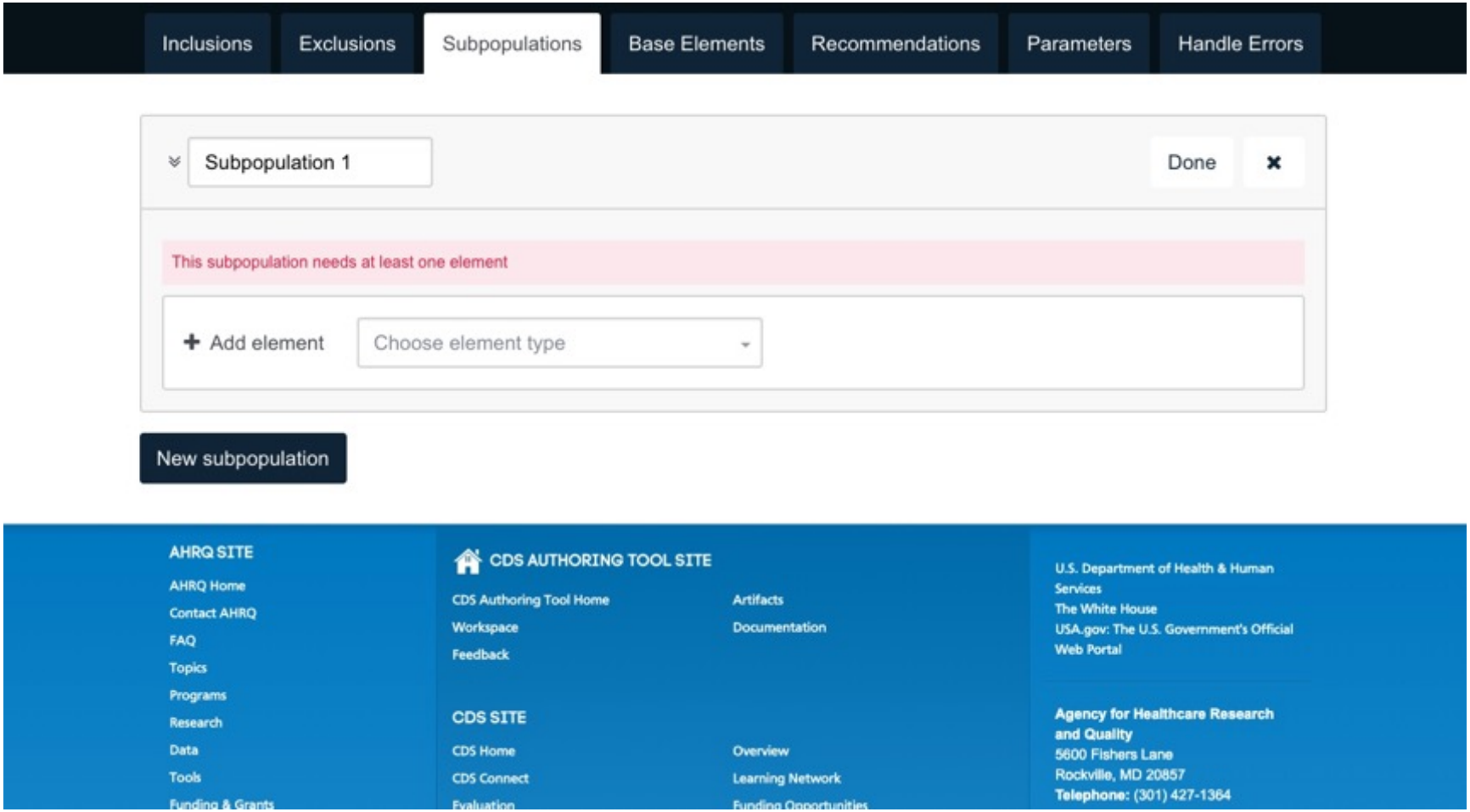


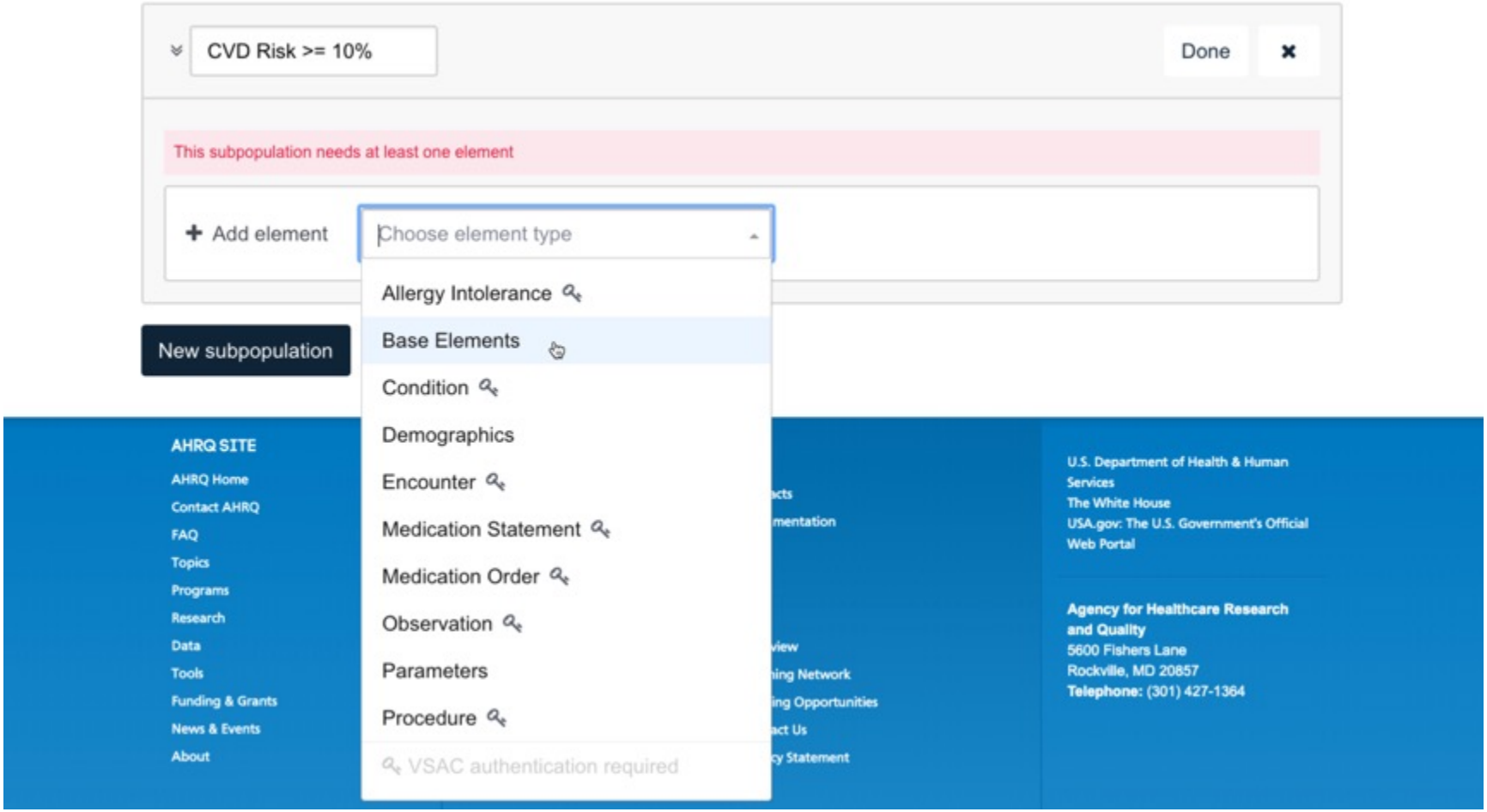
CDS Authoring Tool: Subpopulations



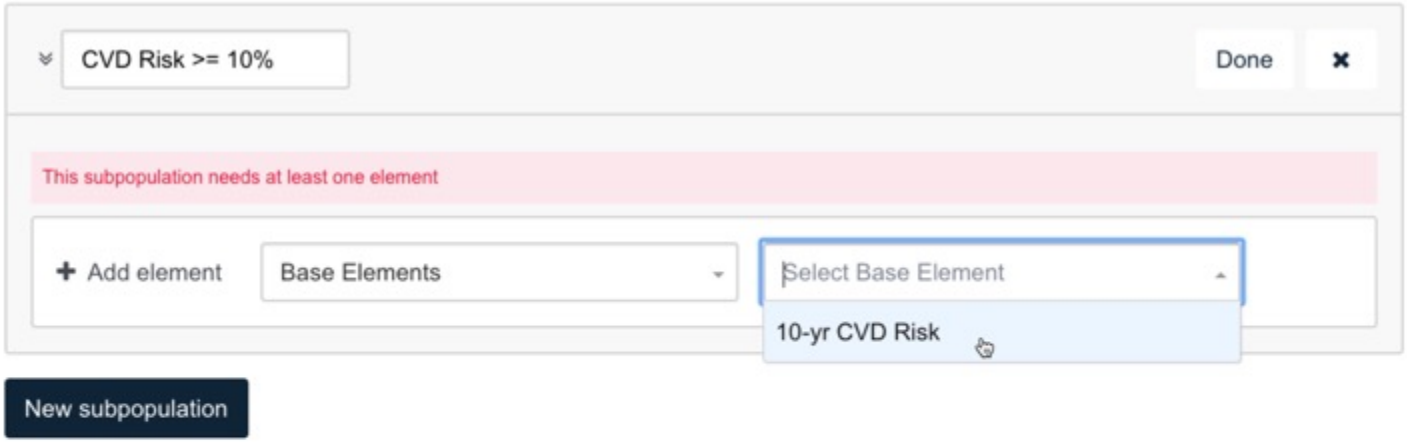
CDS Authoring Tool: Subpopulations

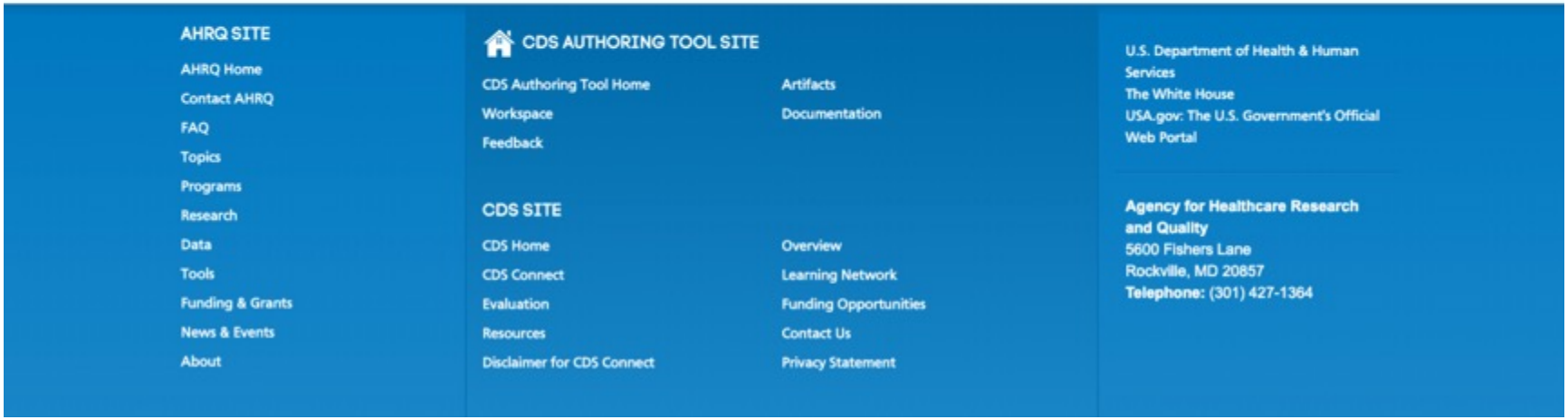


CDS Authoring Tool: Subpopulations



CDS Authoring Tool: Subpopulations





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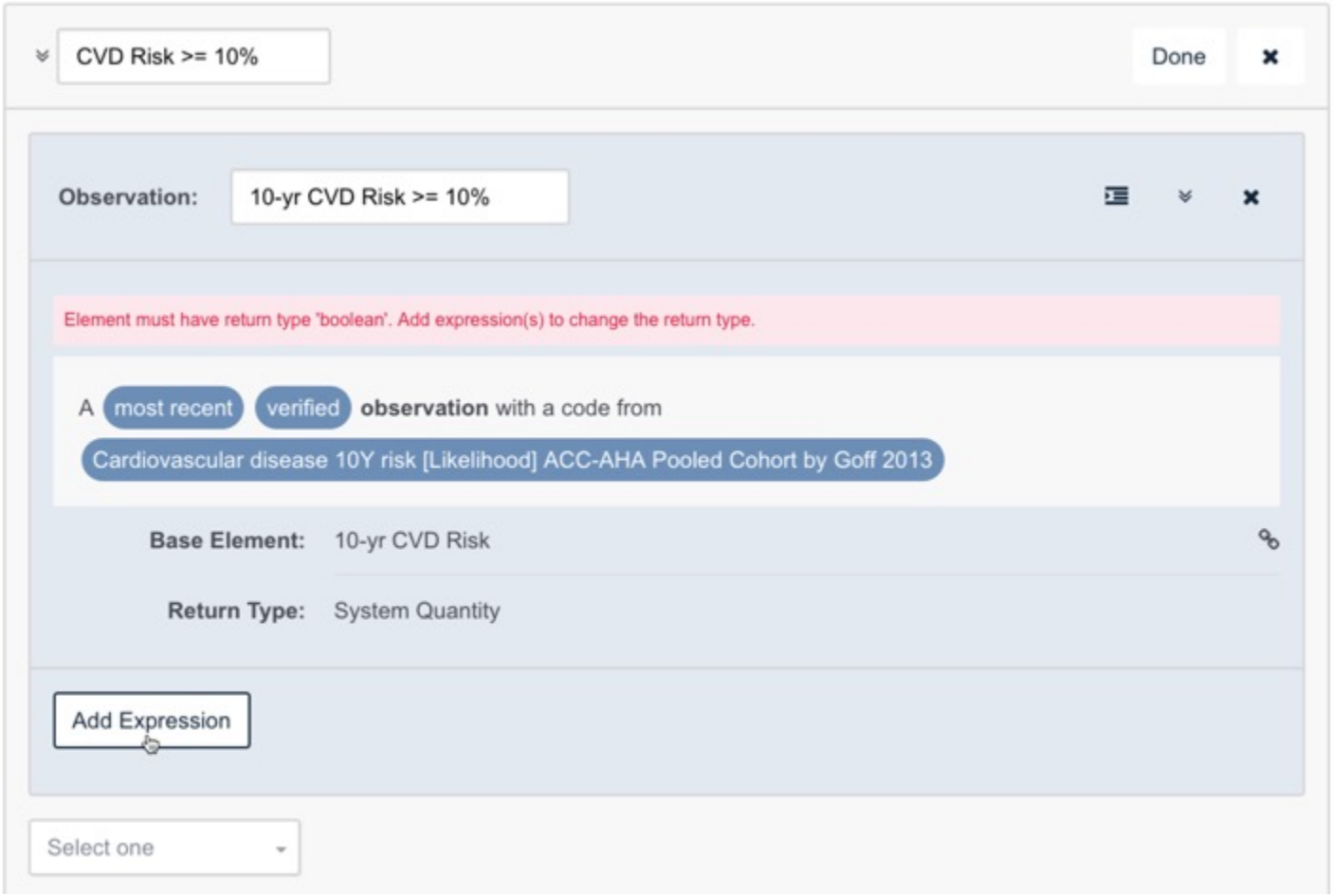
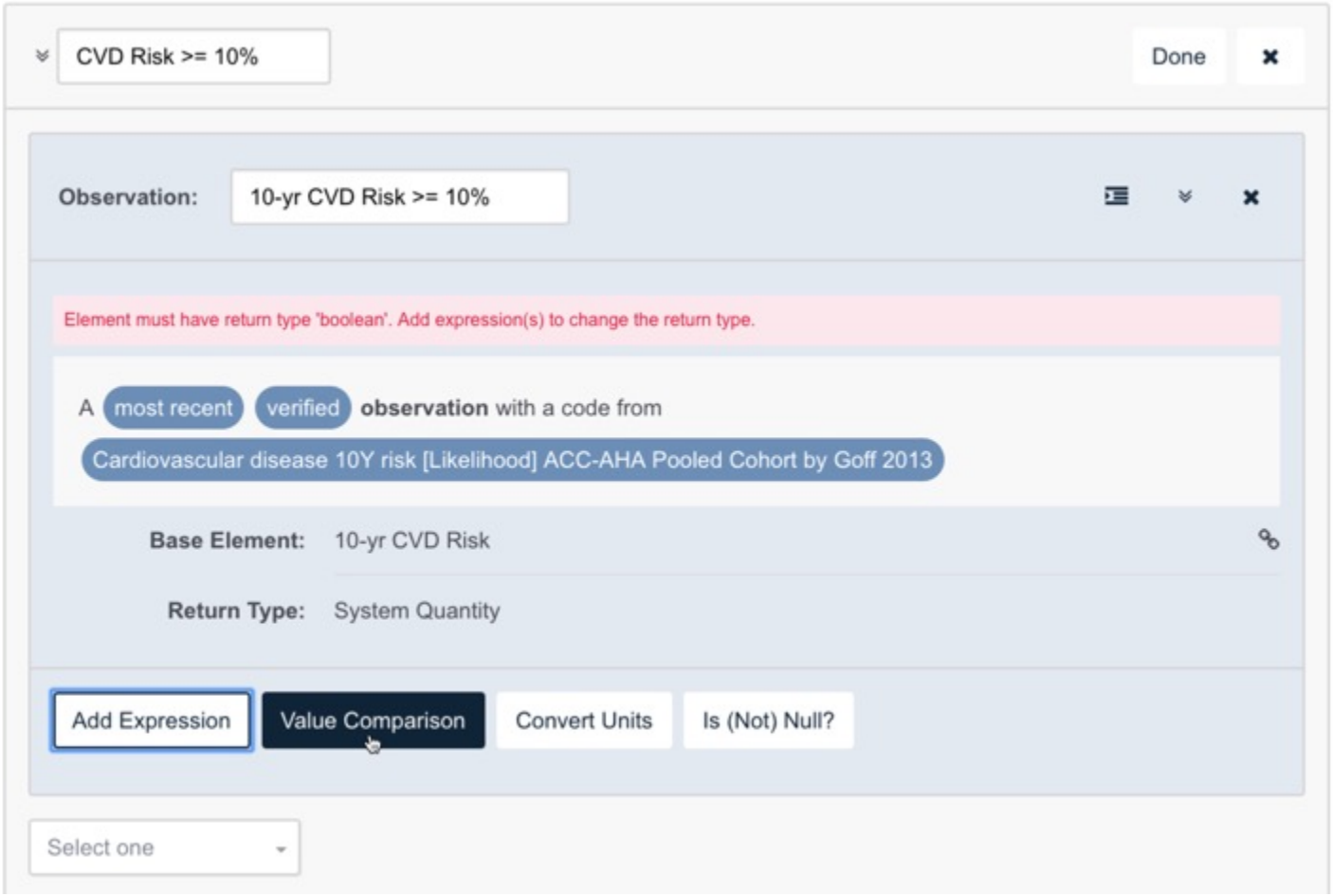
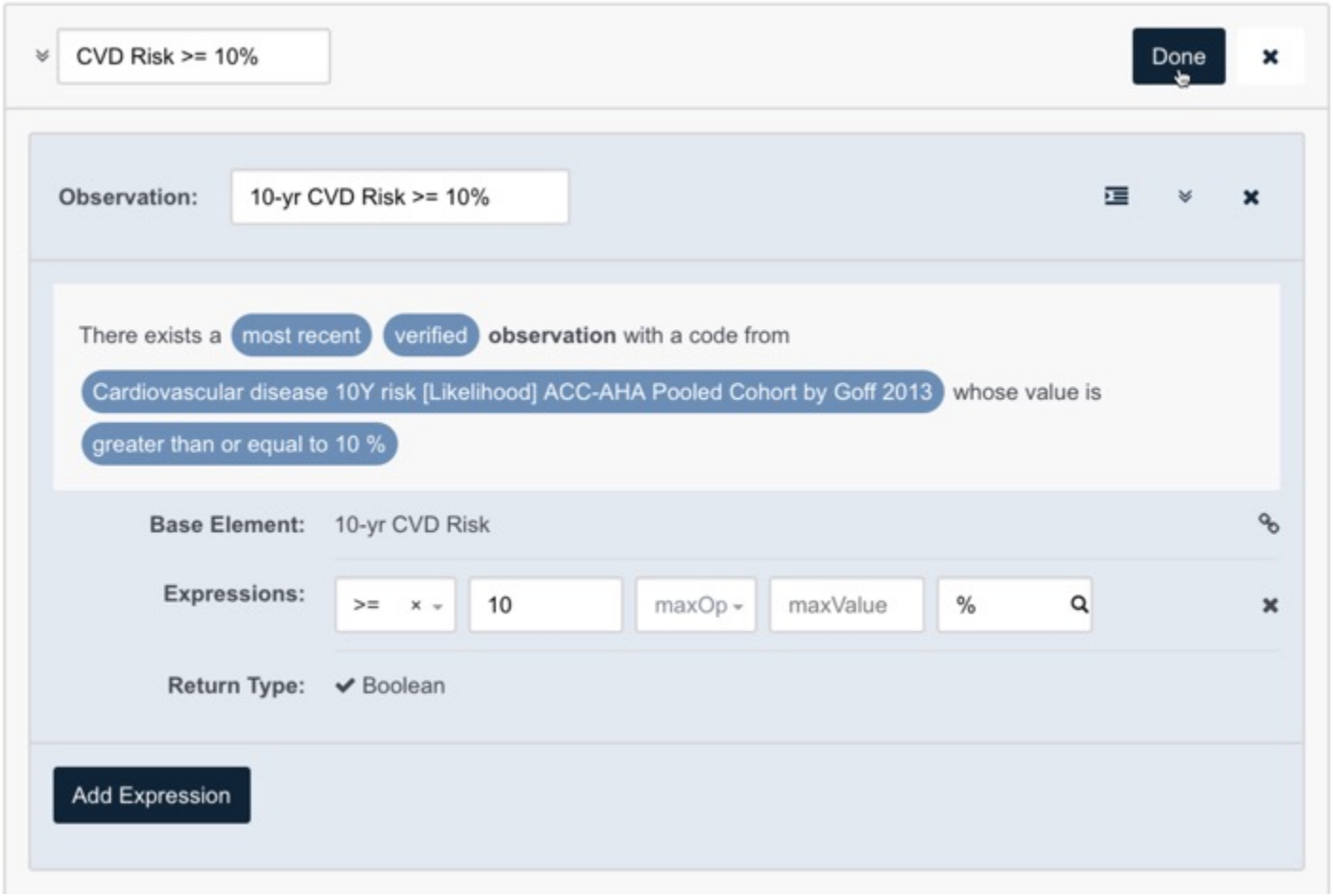


CDS Authoring Tool: Subpopulations



CDS Authoring Tool: Subpopulations



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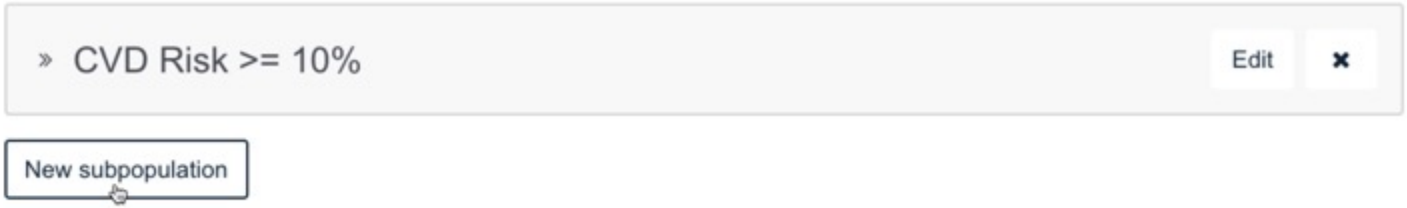
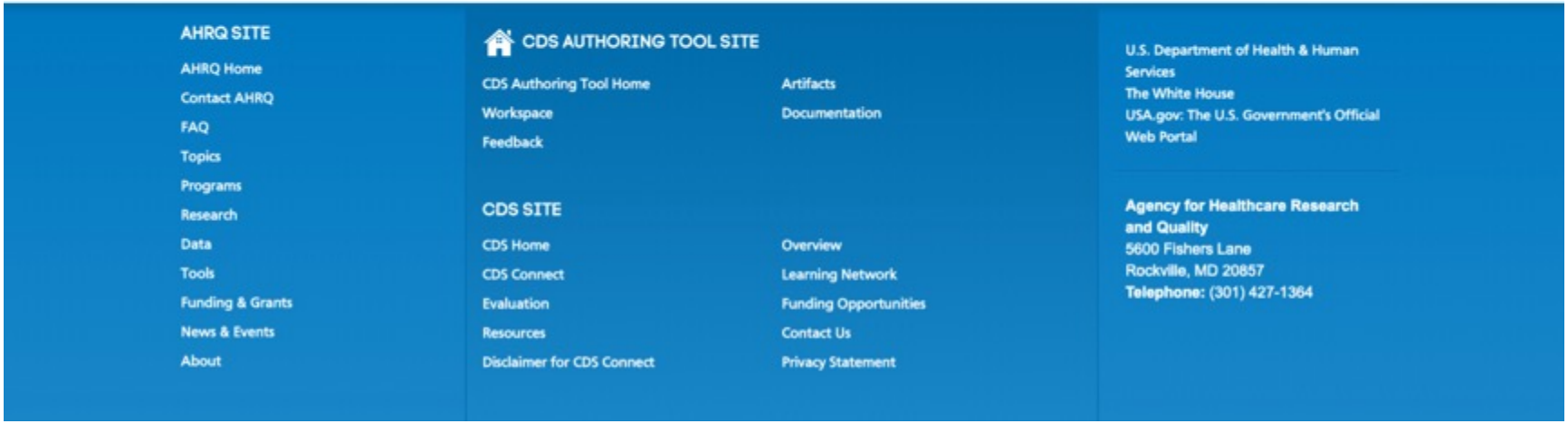
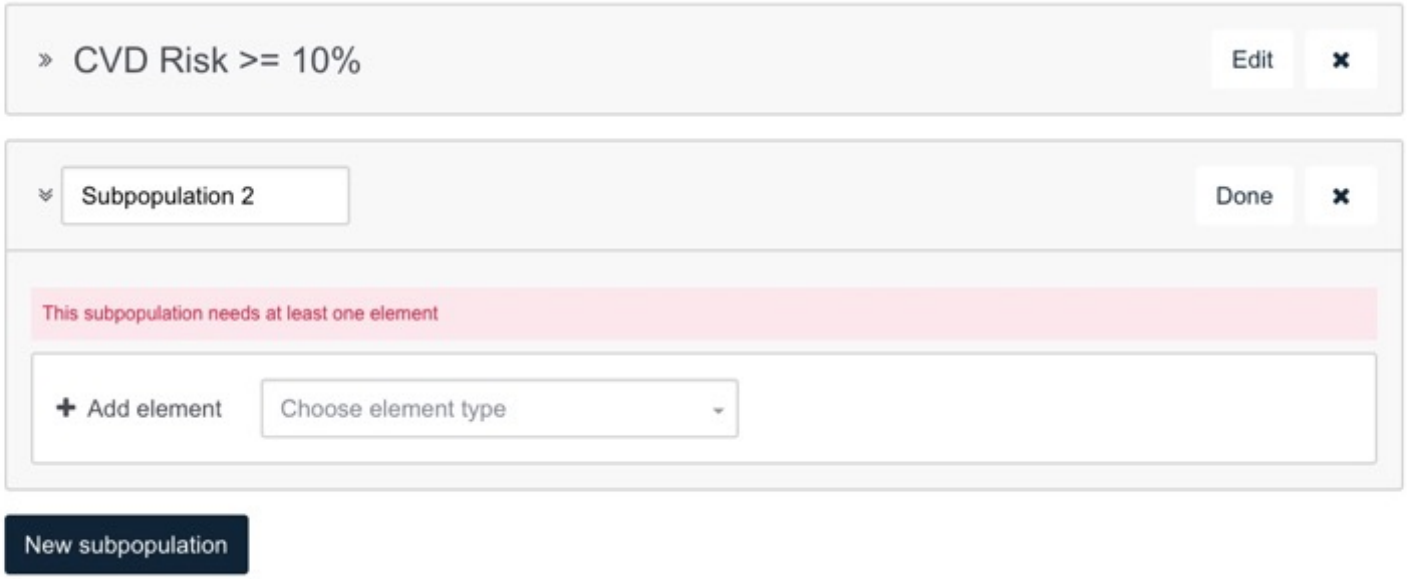




CDS Authoring Tool: Subpopulations



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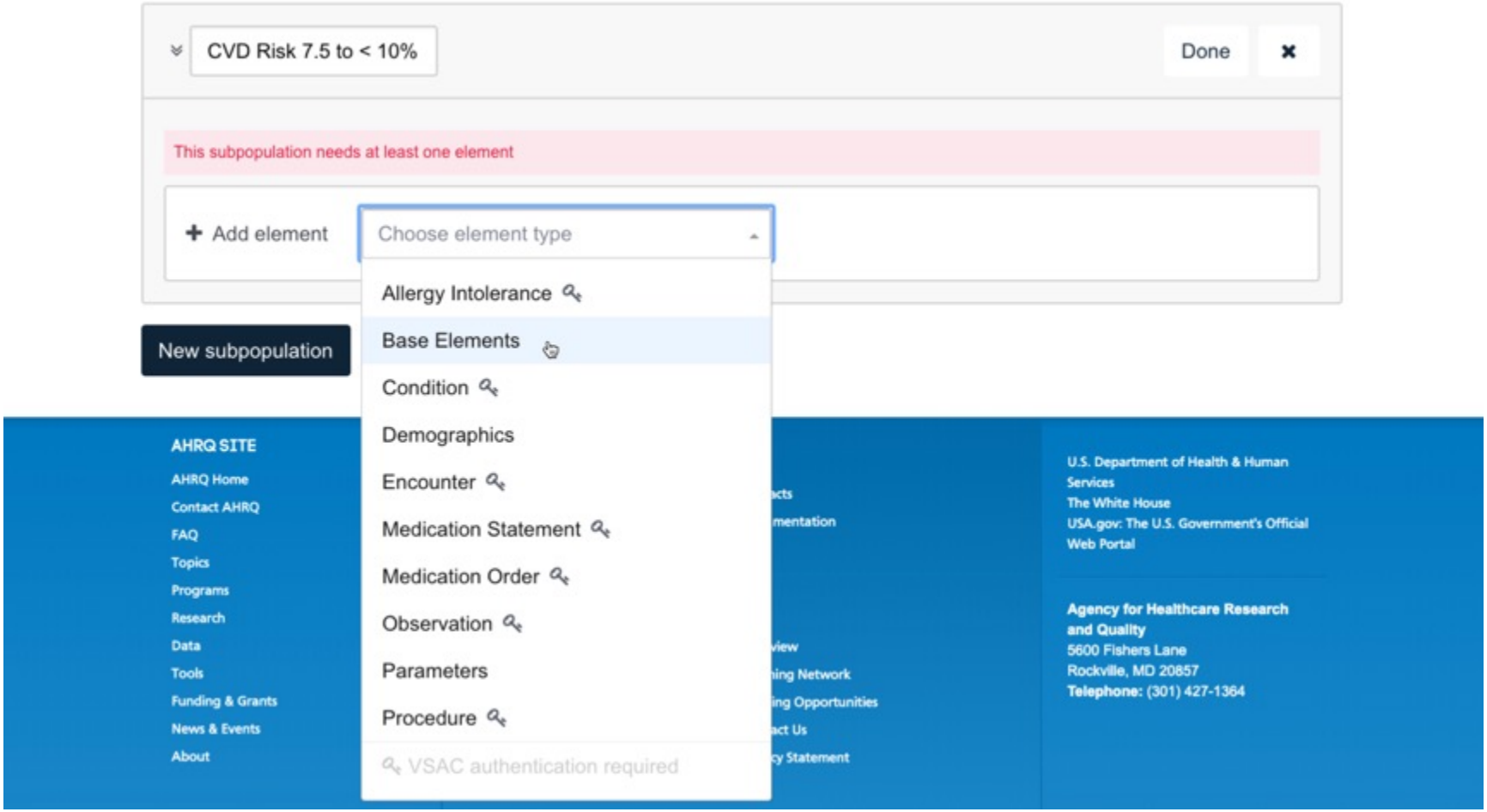

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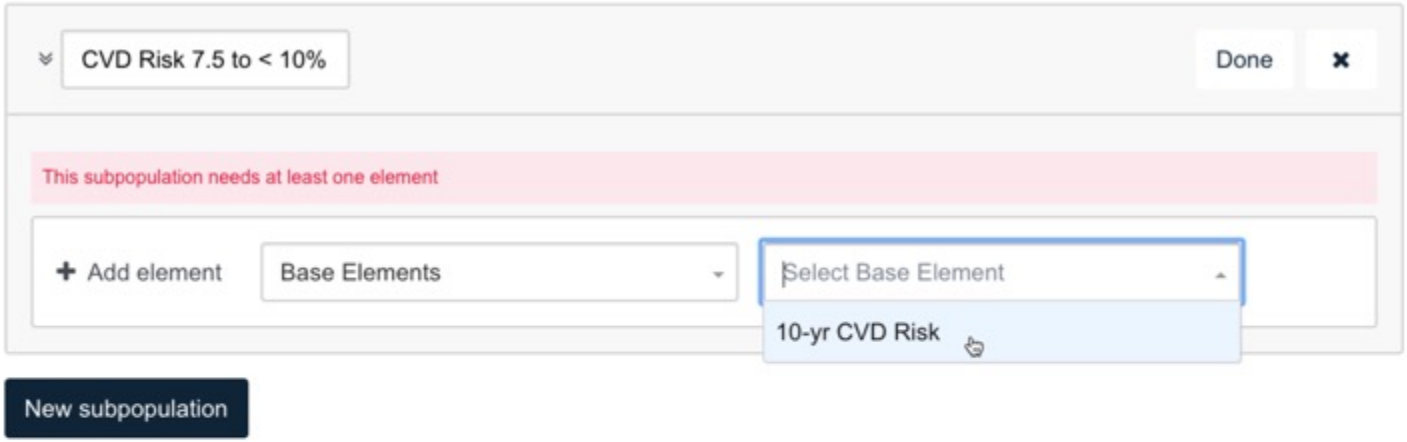

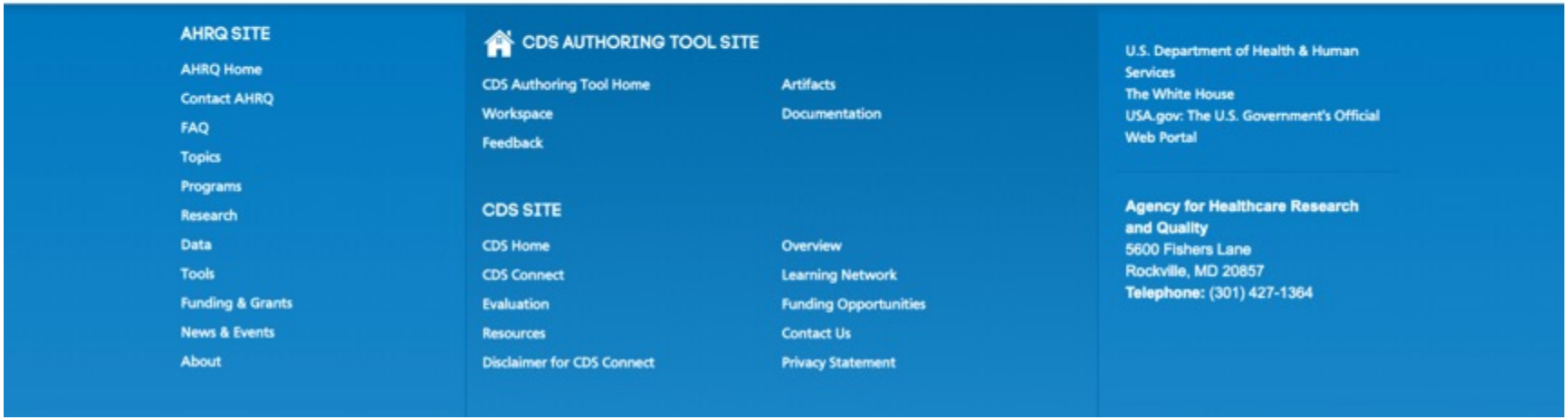

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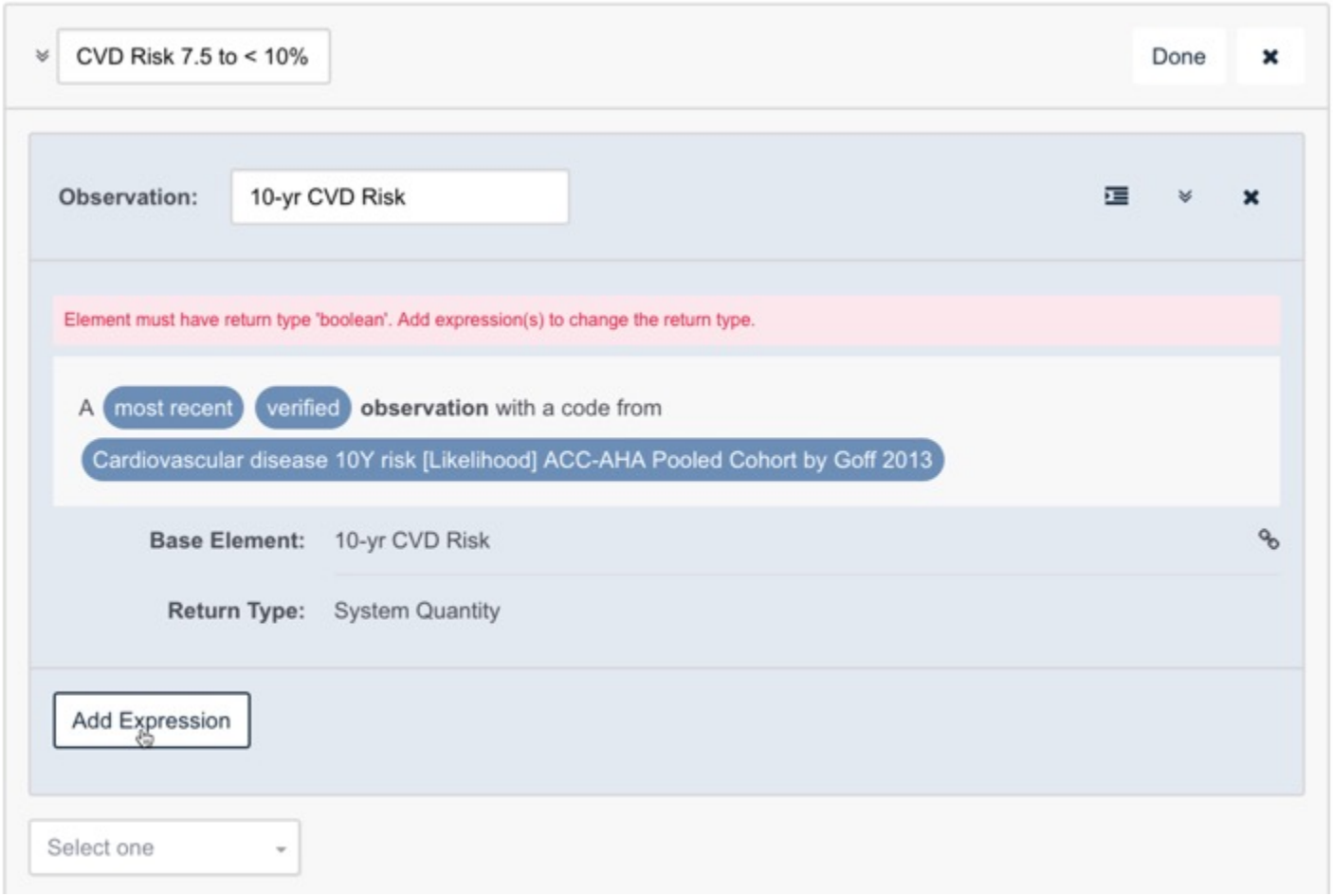
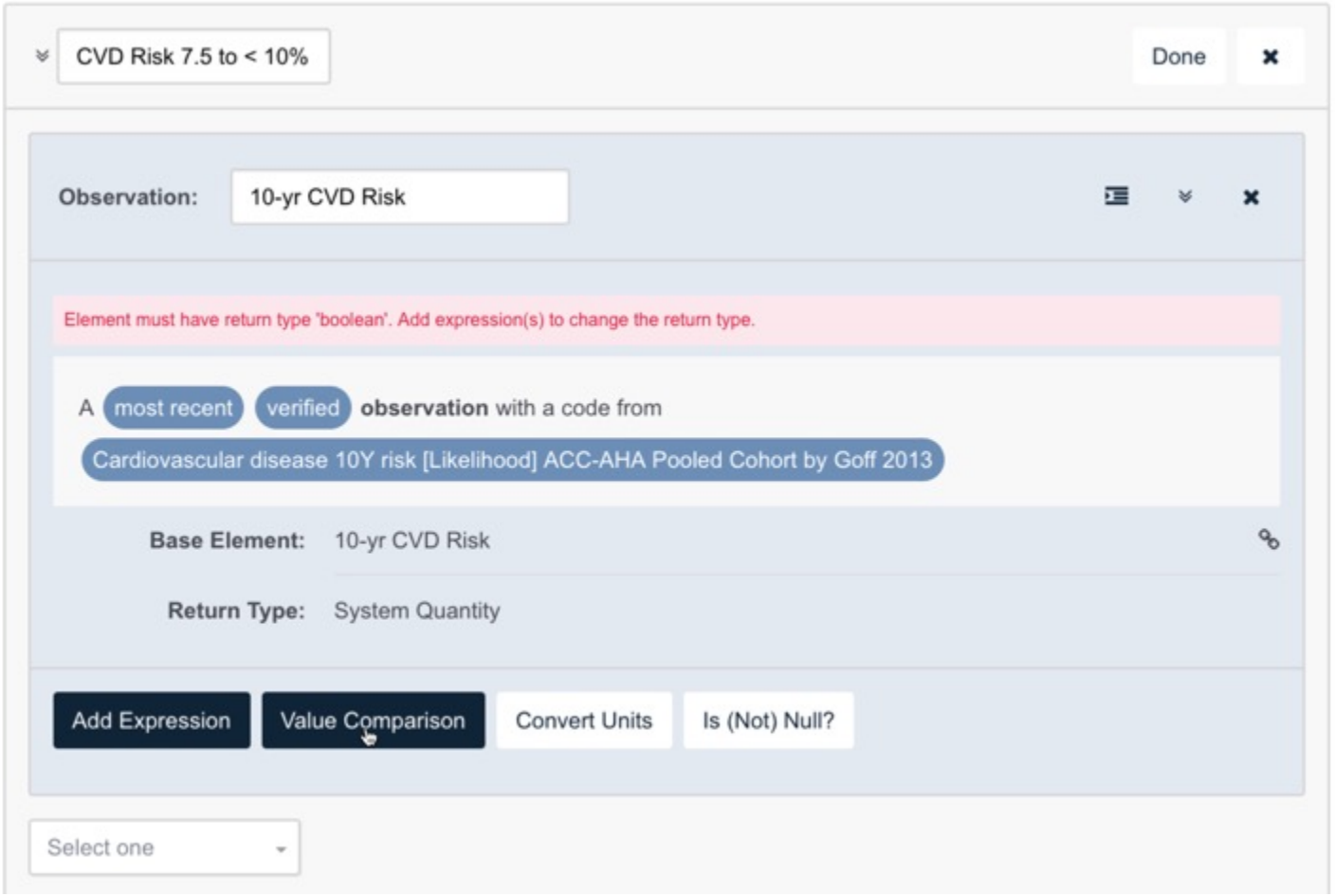
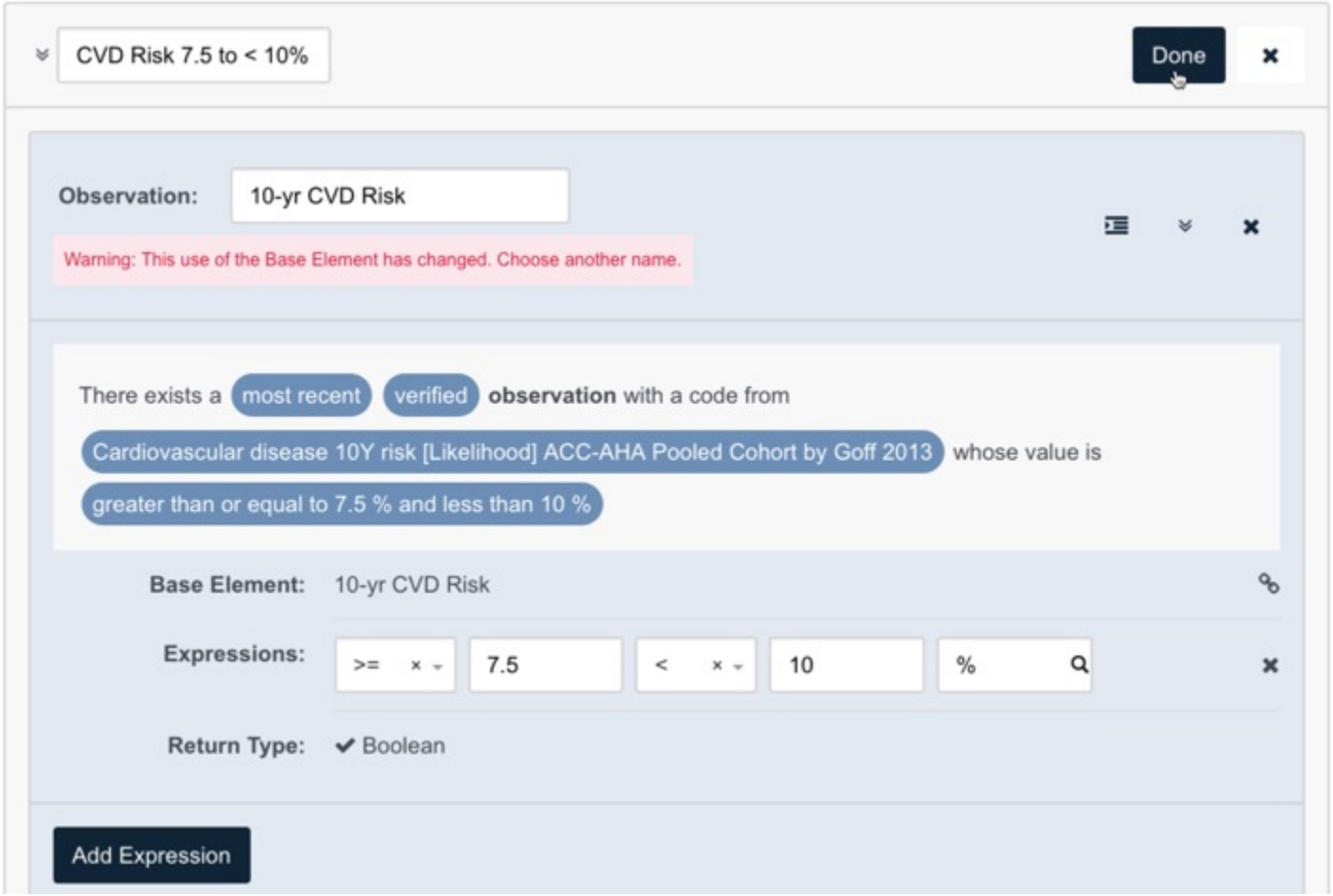


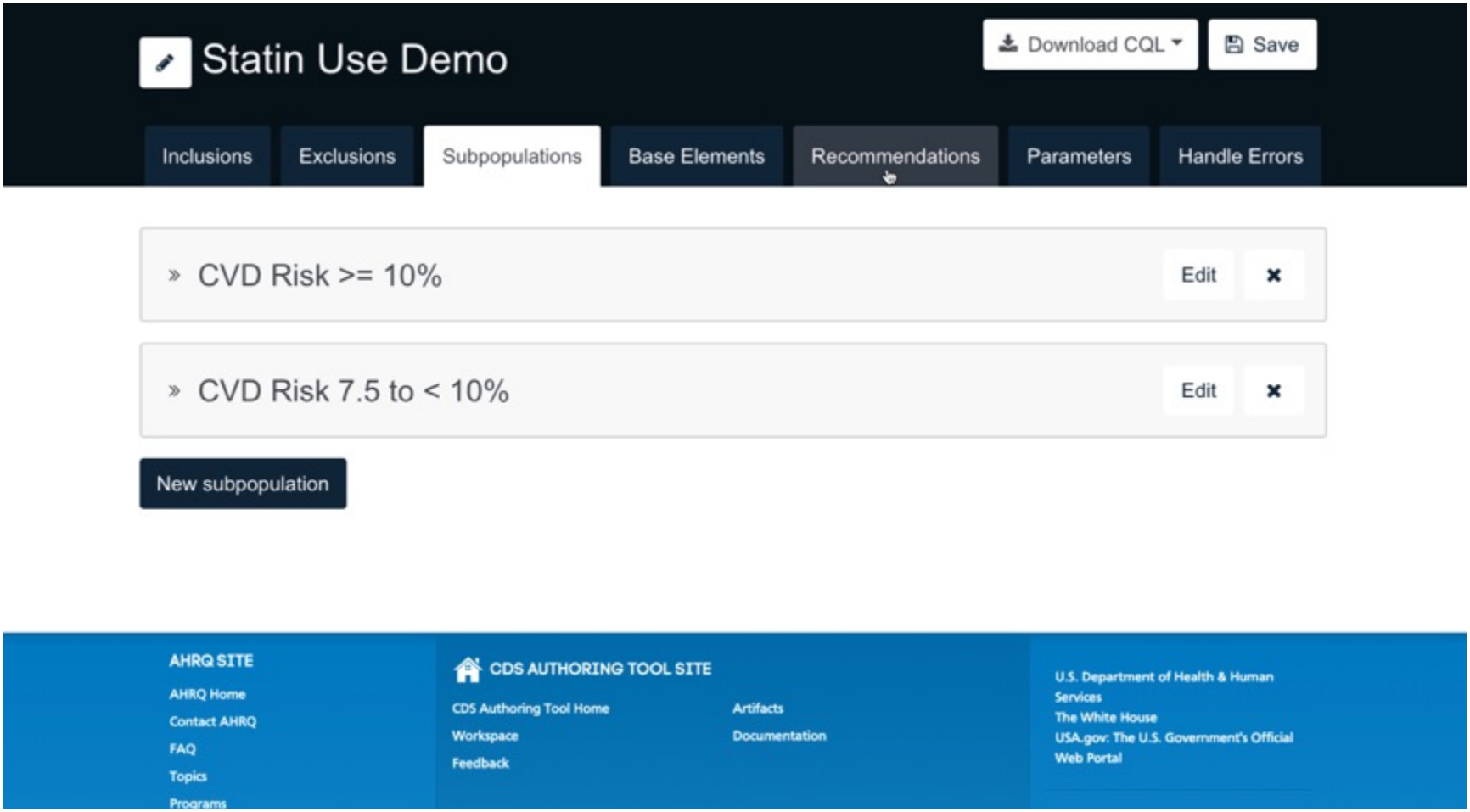
CDS Authoring Tool: Subpopulations



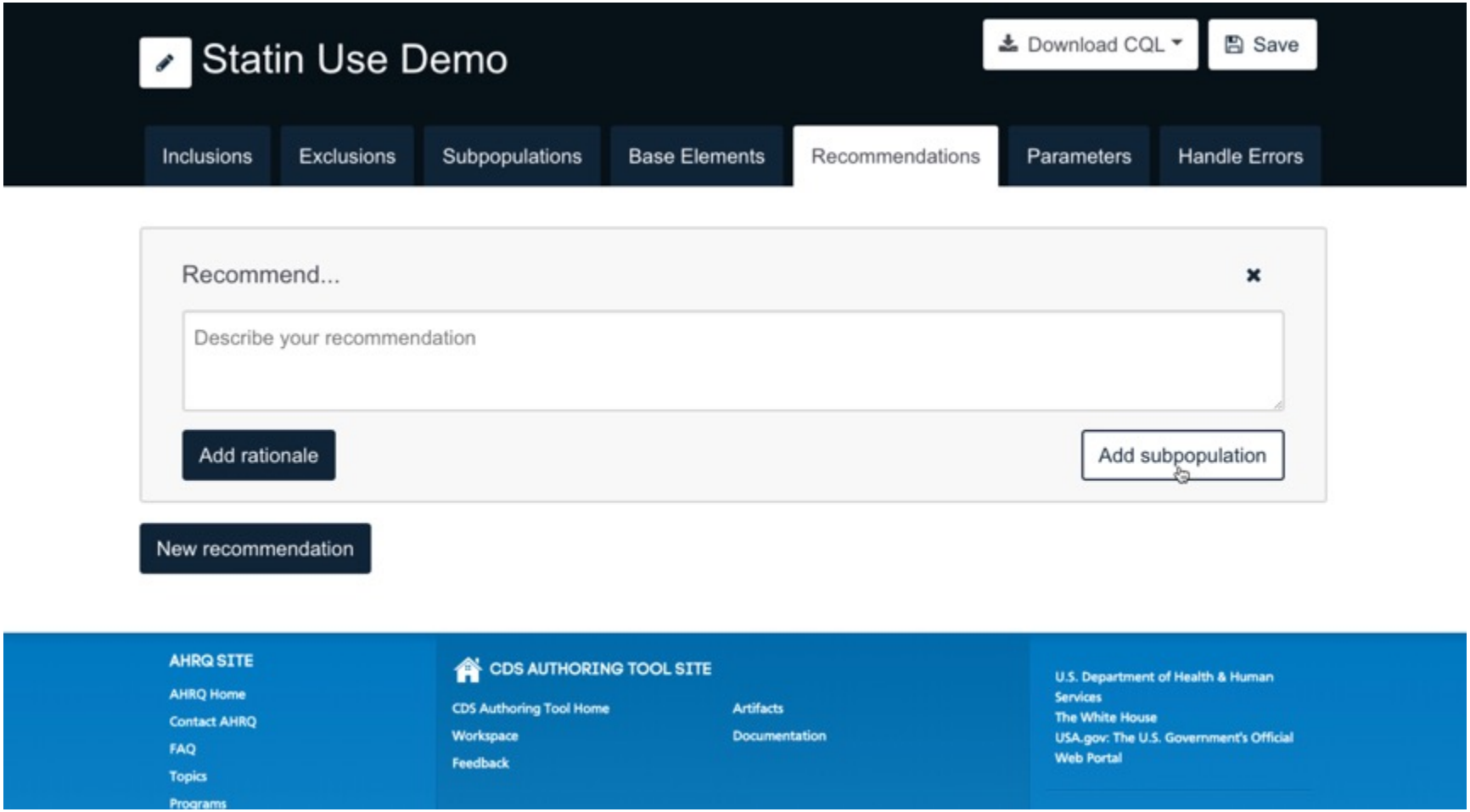
CDS Authoring Tool: Subpopulations



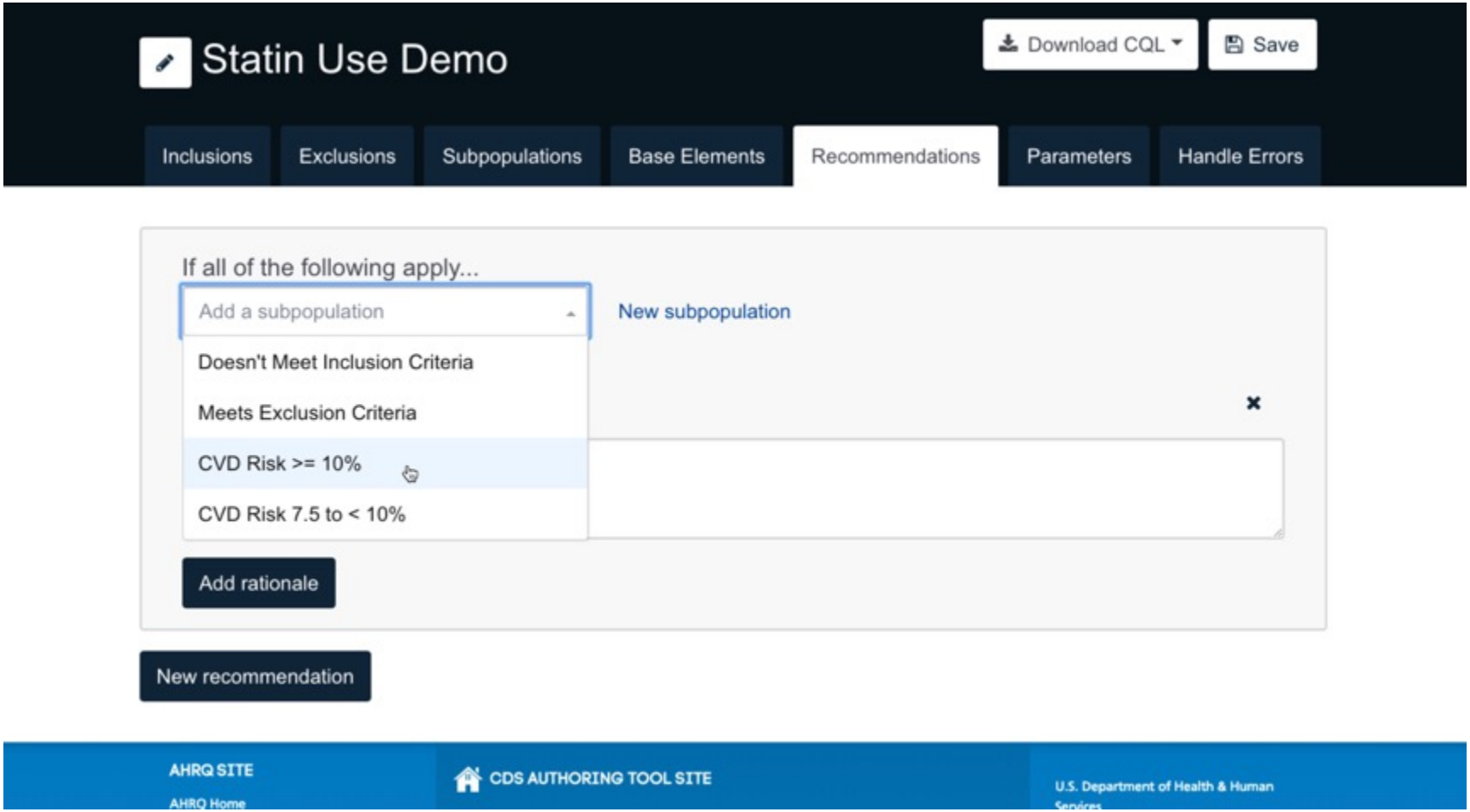
CDS Authoring Tool: Recommendations



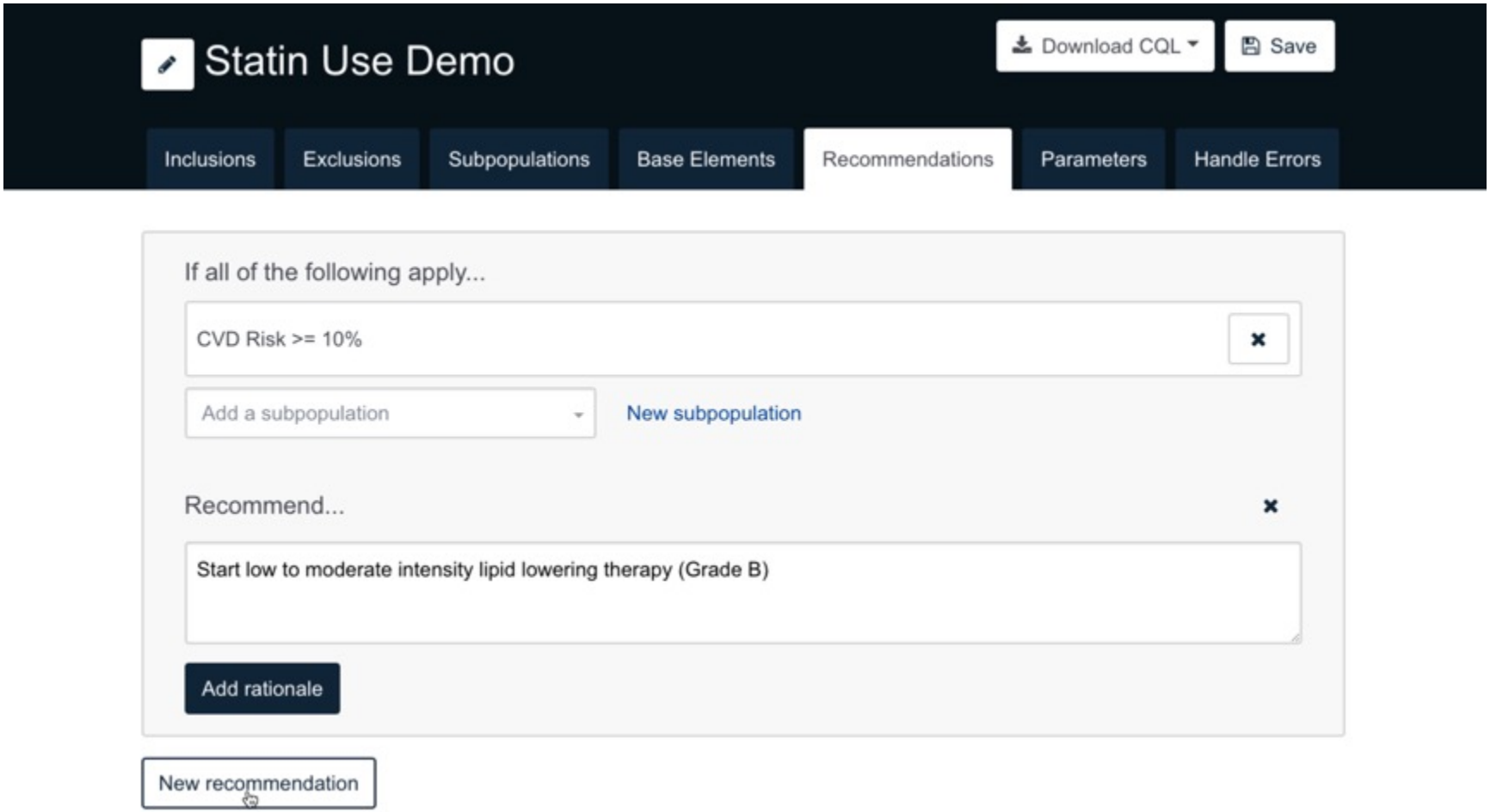
CDS Authoring Tool: Recommendations



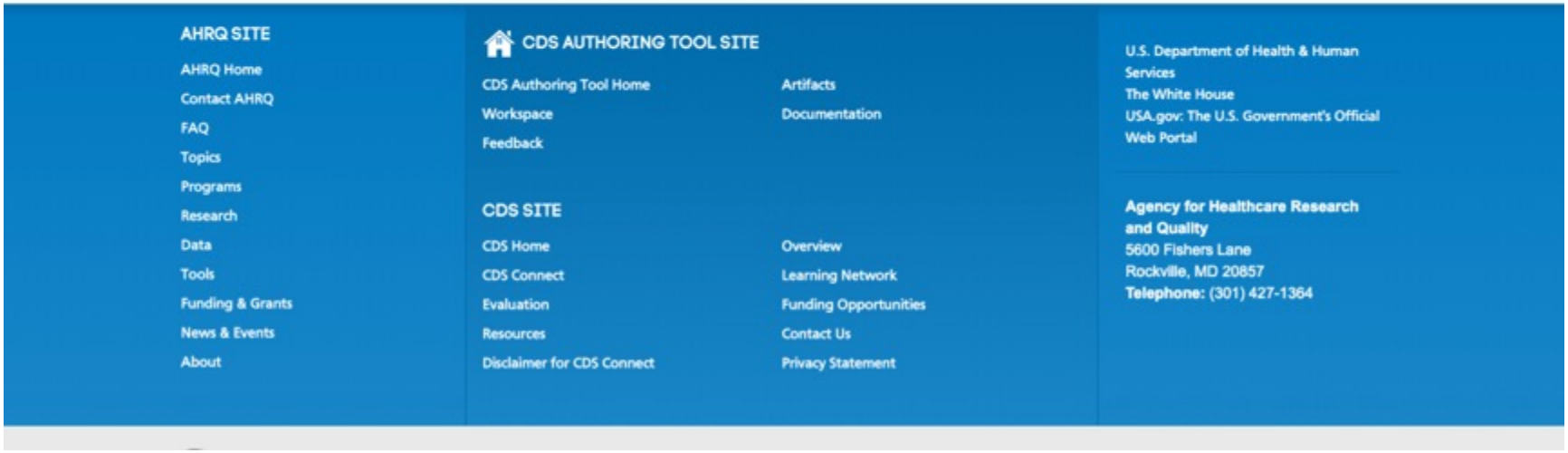
CDS Authoring Tool: Recommendations



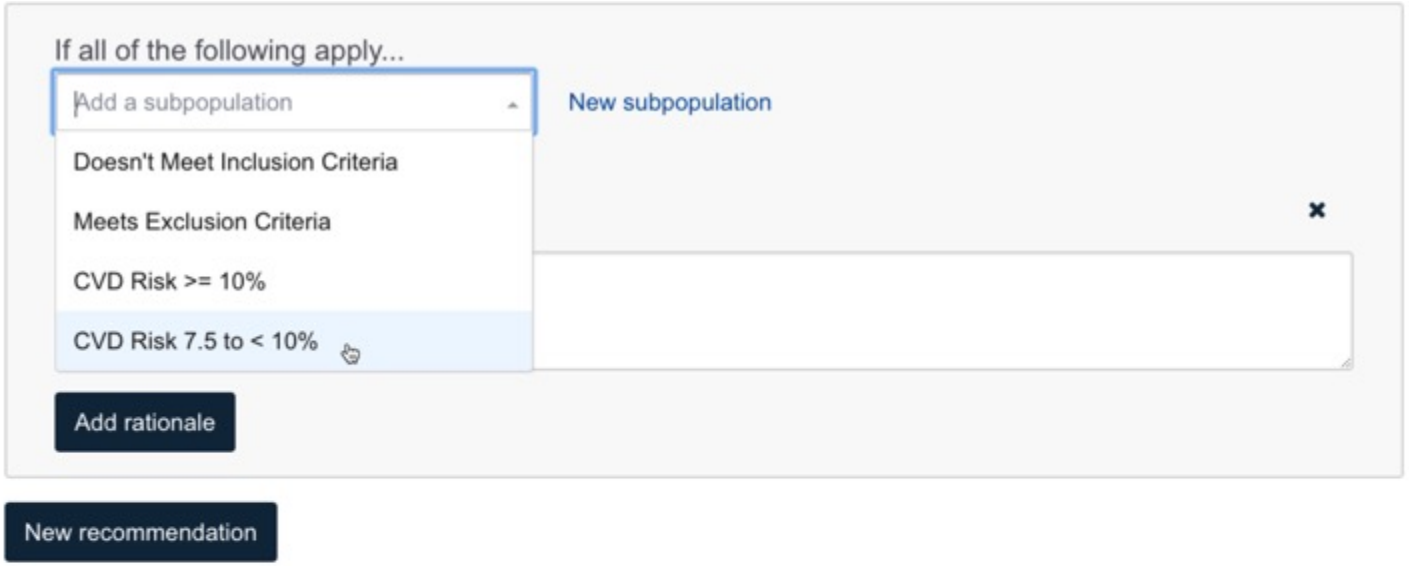
CDS Authoring Tool: Recommendations



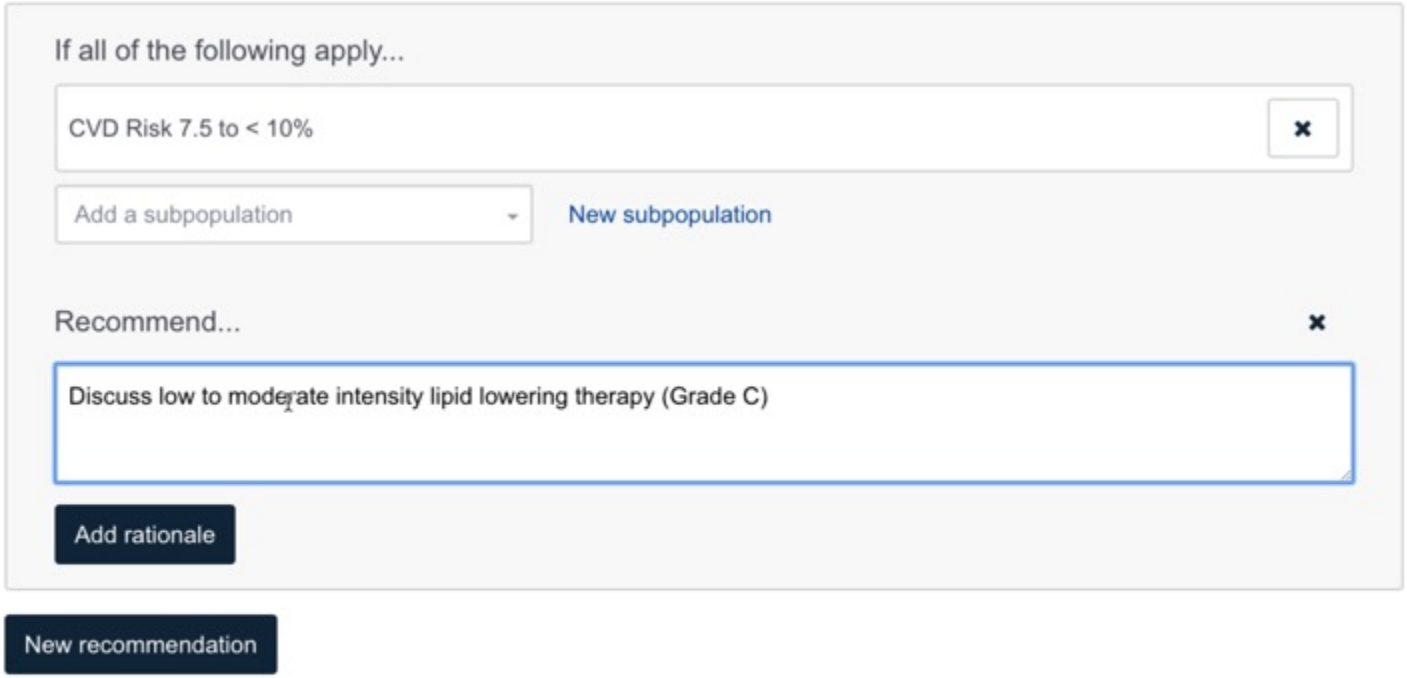
CDS Authoring Tool: Recommendations



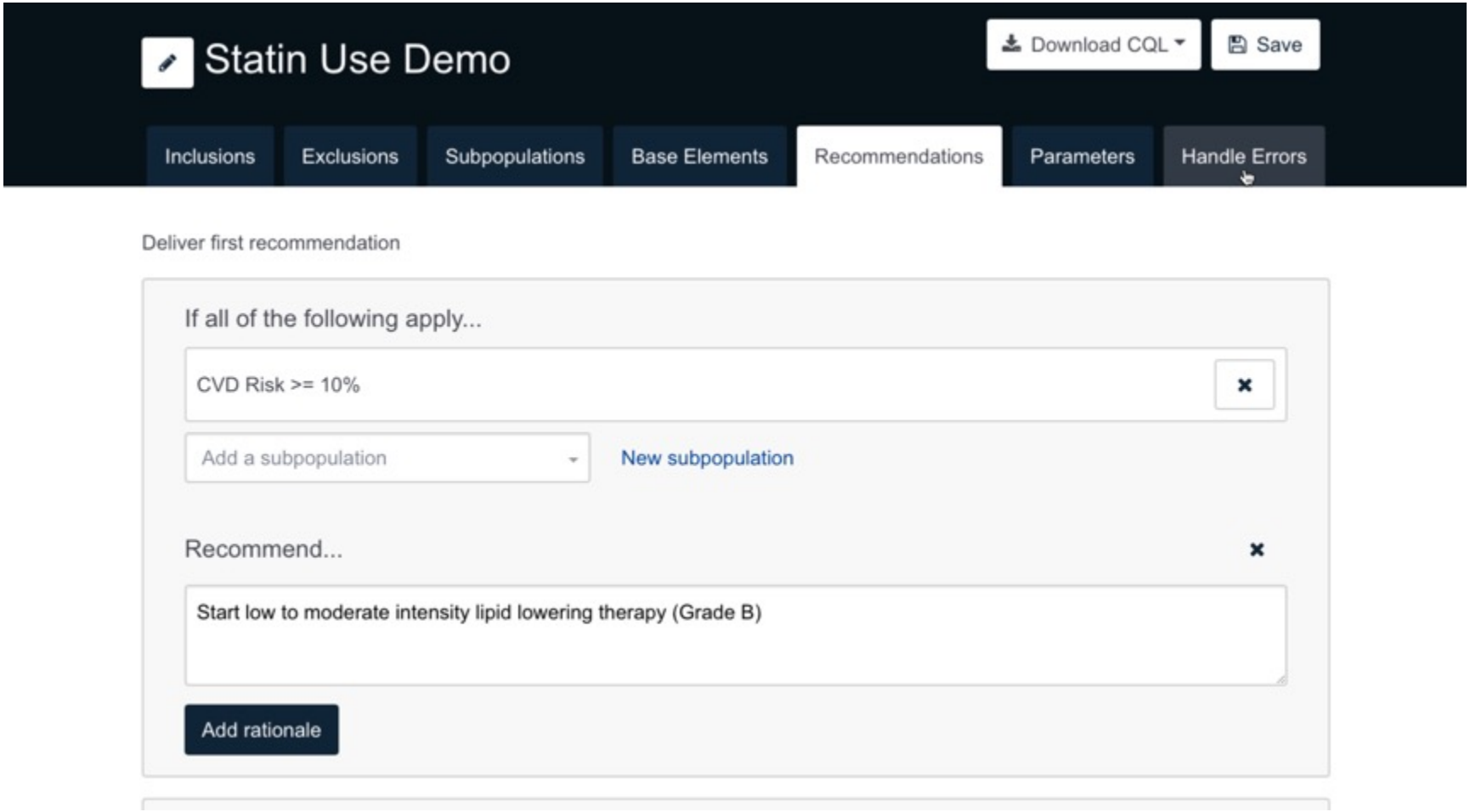
CDS Authoring Tool: Recommendations



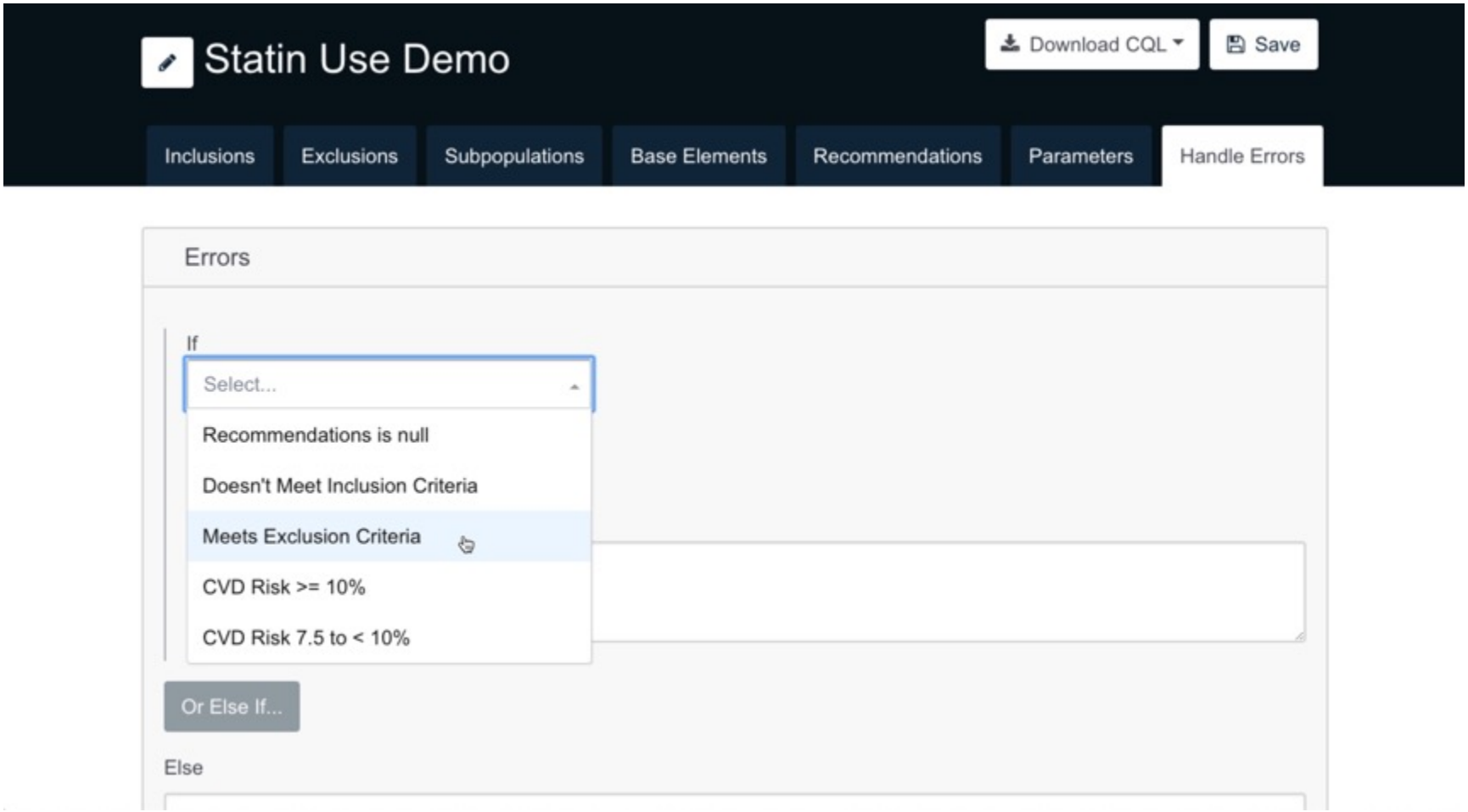
CDS Authoring Tool: Recommendations



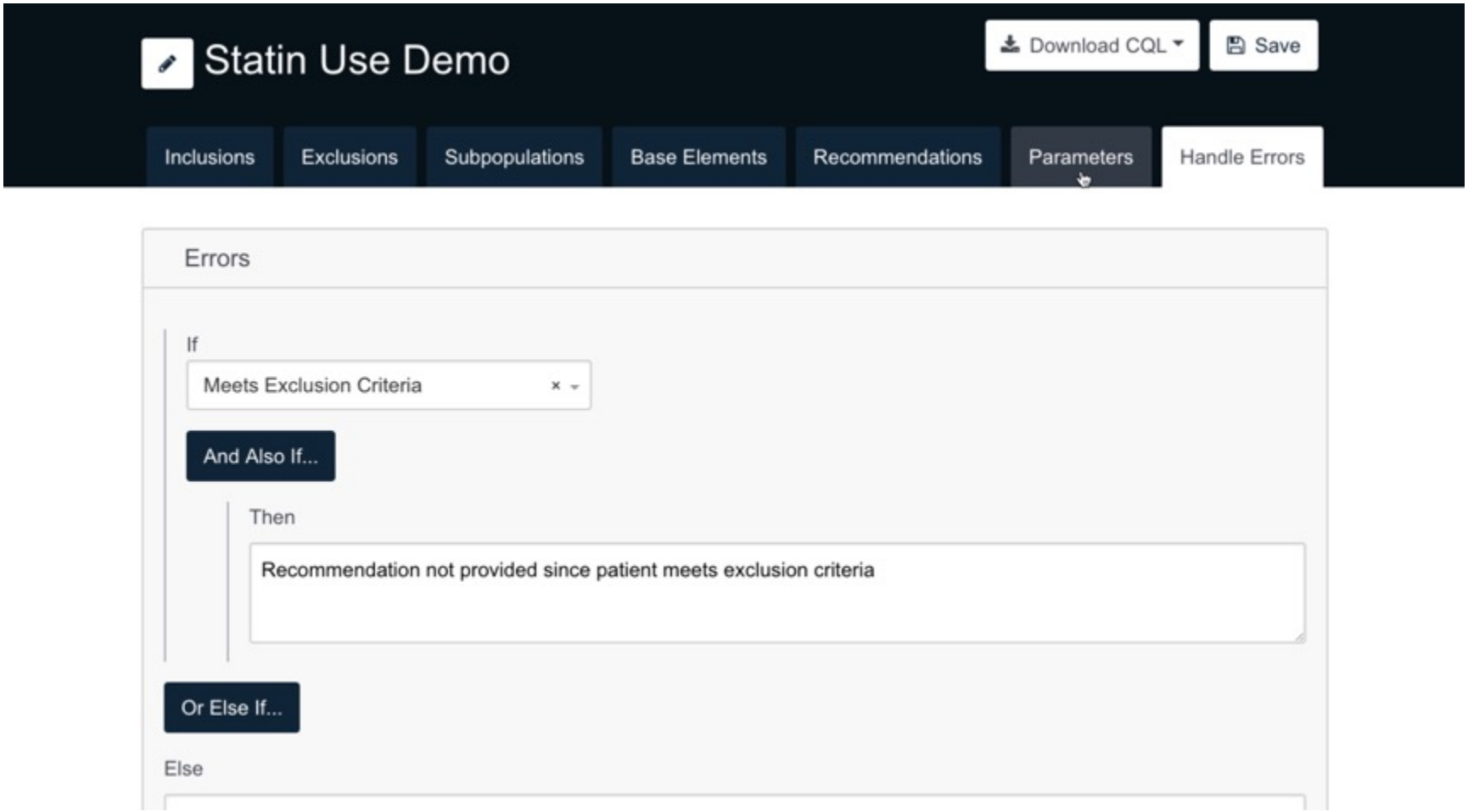
CDS Authoring Tool: Handle Errors



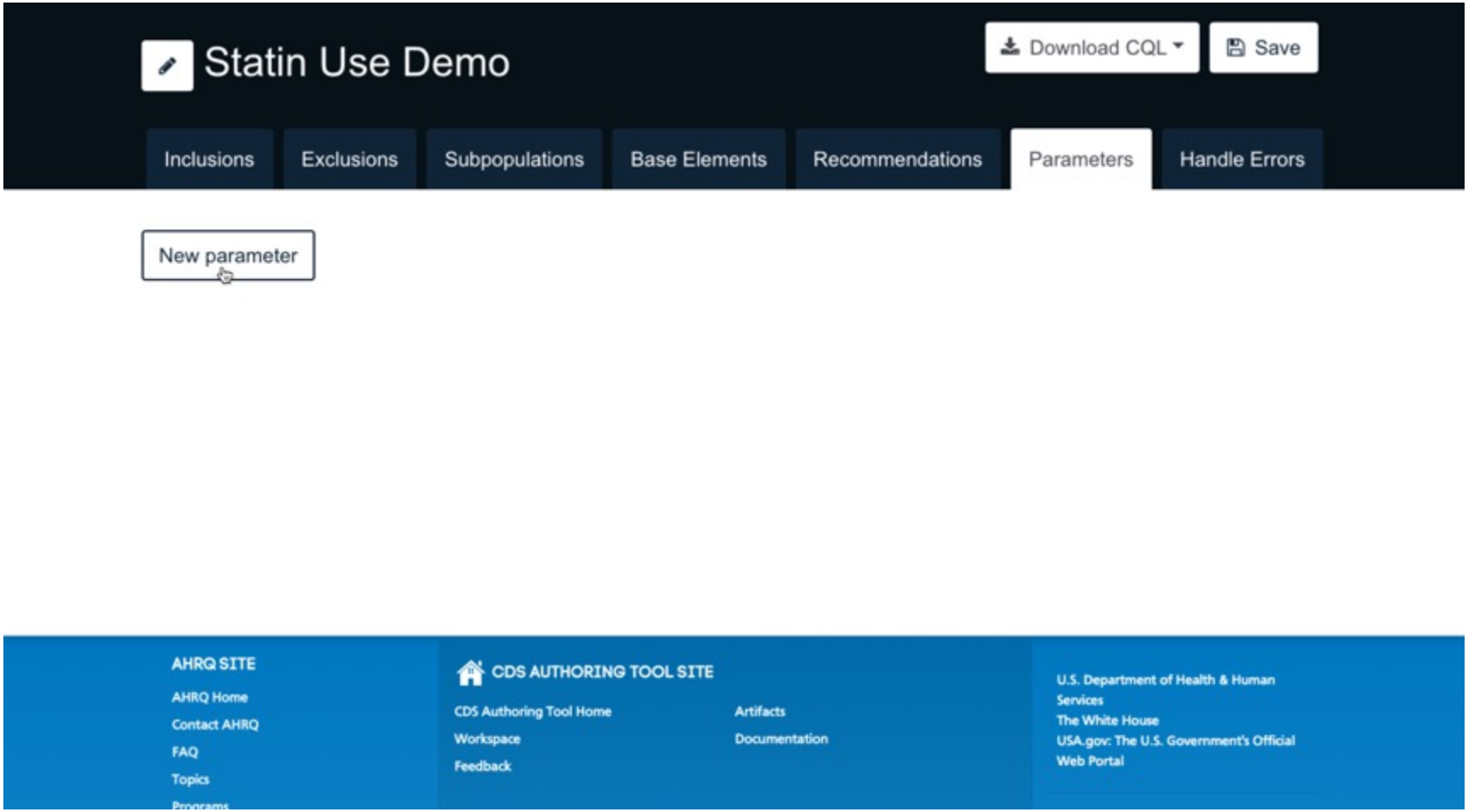
CDS Authoring Tool: Handle Errors



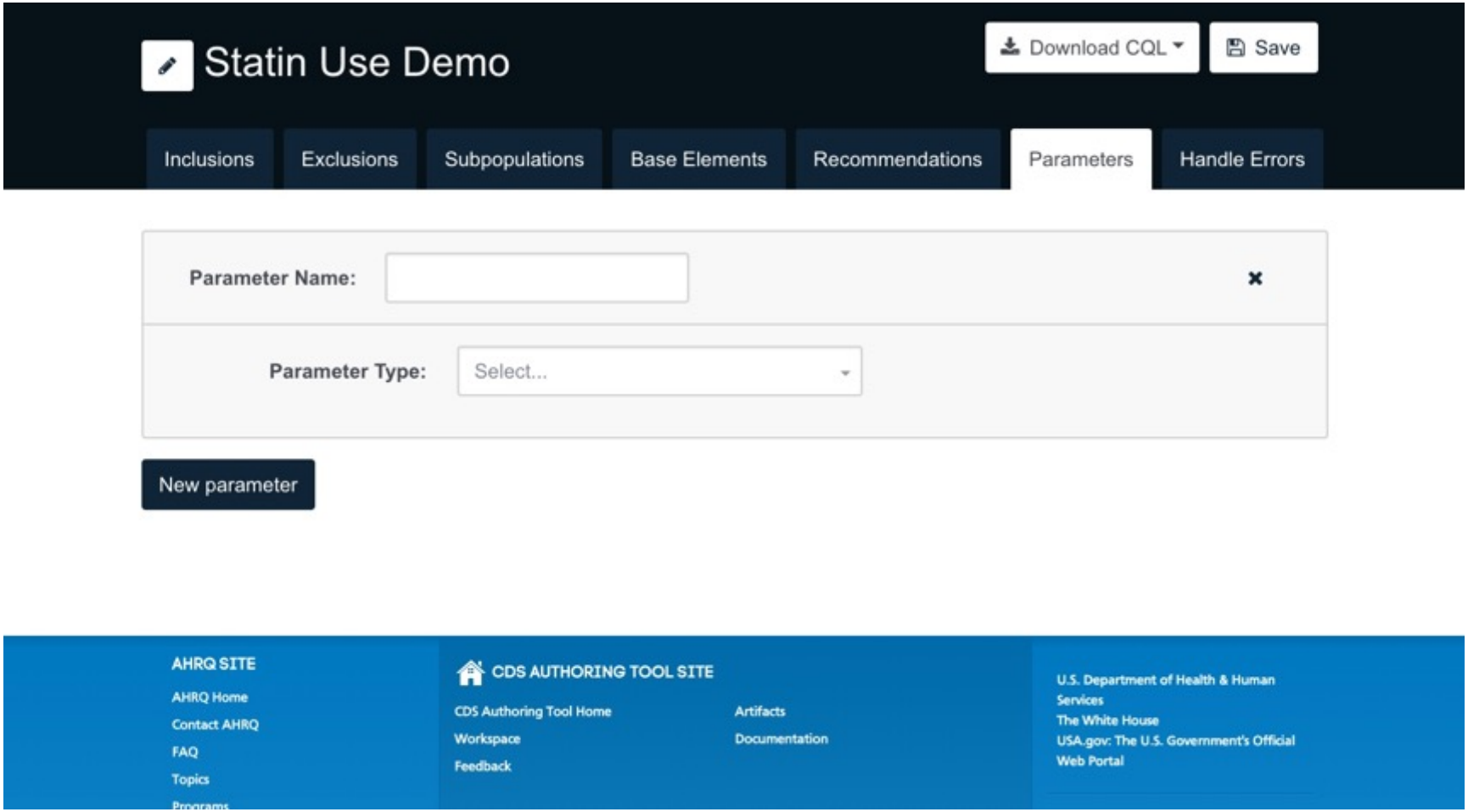
CDS Authoring Tool: Parameters



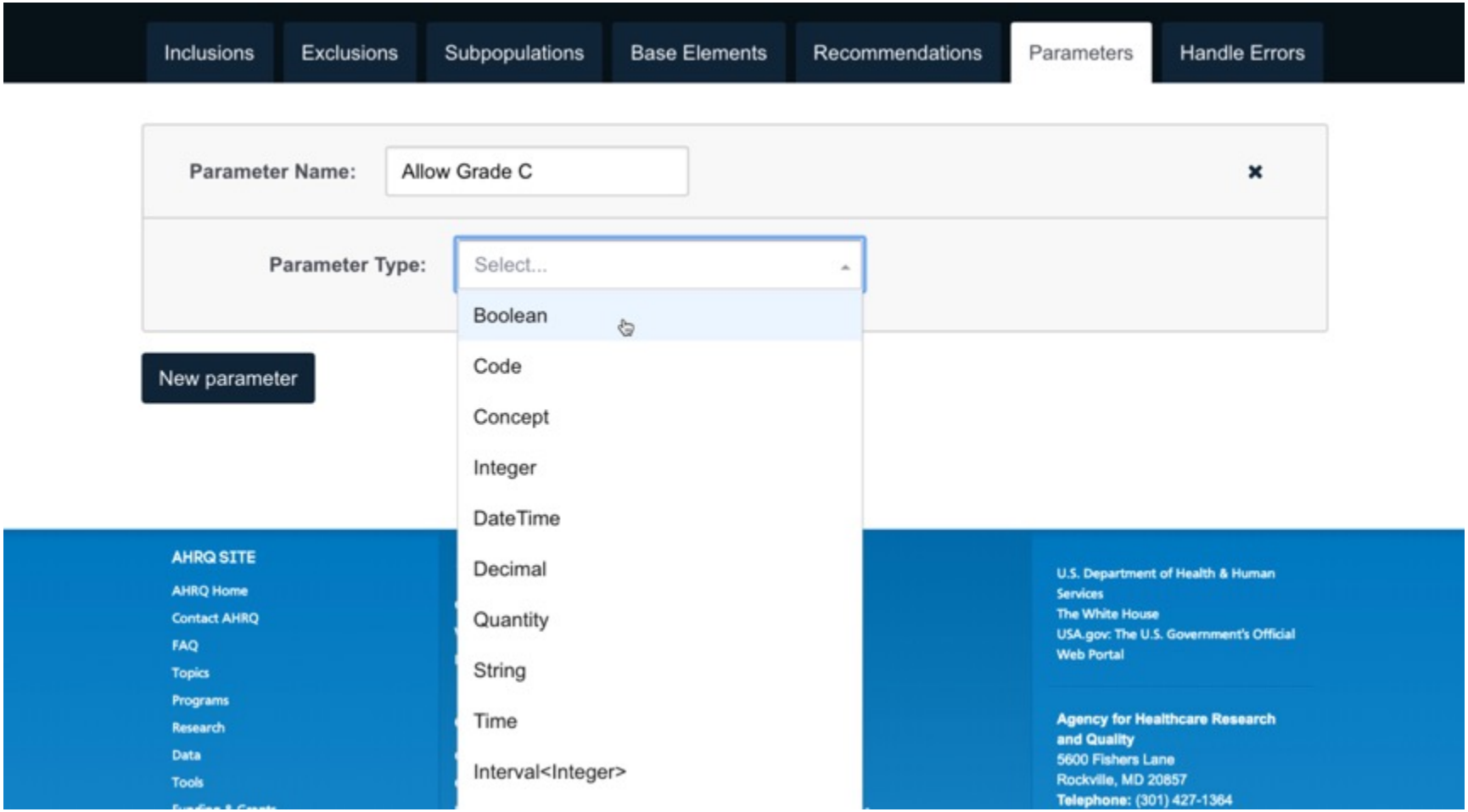
CDS Authoring Tool: Parameters



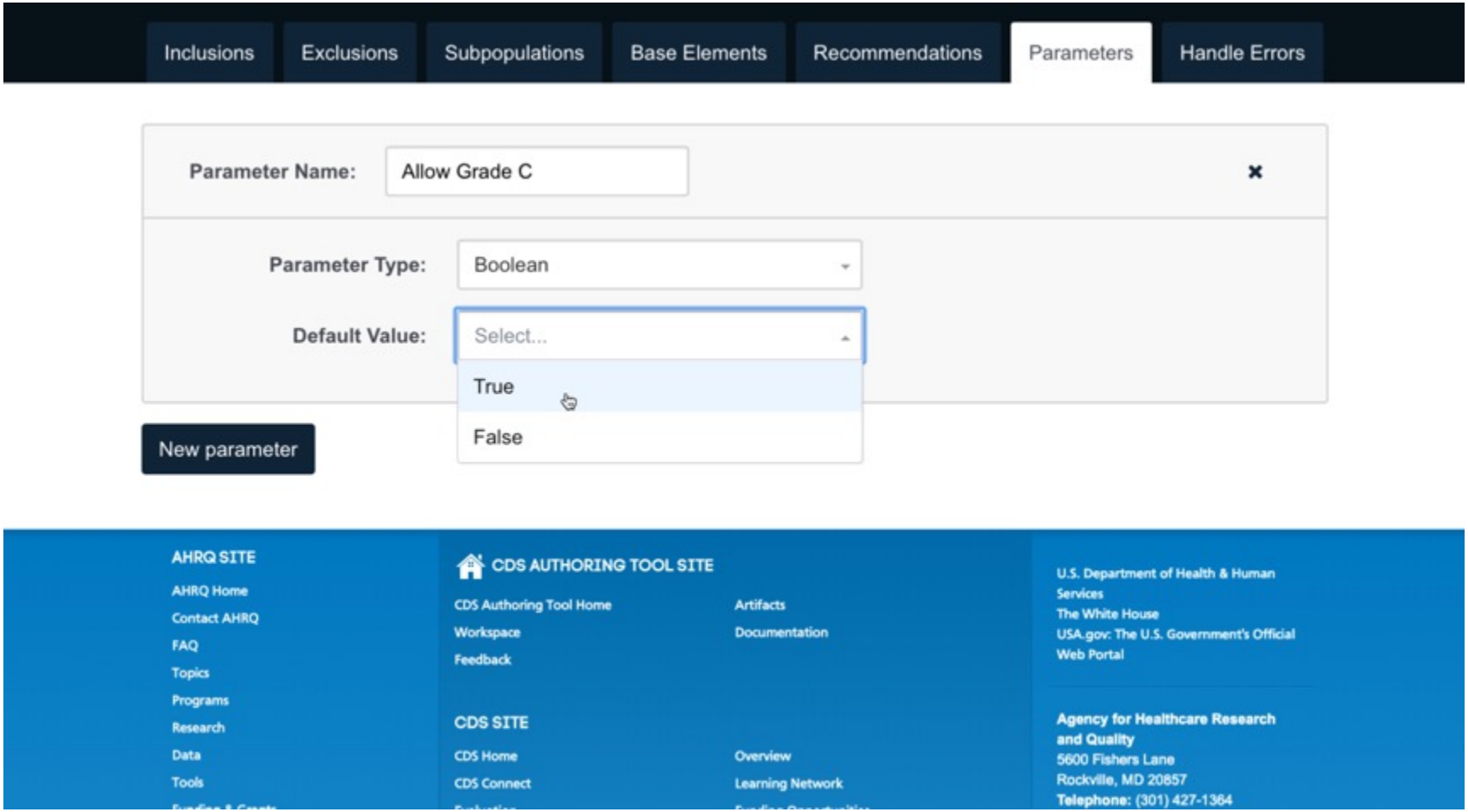
CDS Authoring Tool: Parameters



CDS Authoring Tool: Parameters



CDS Authoring Tool: Parameters



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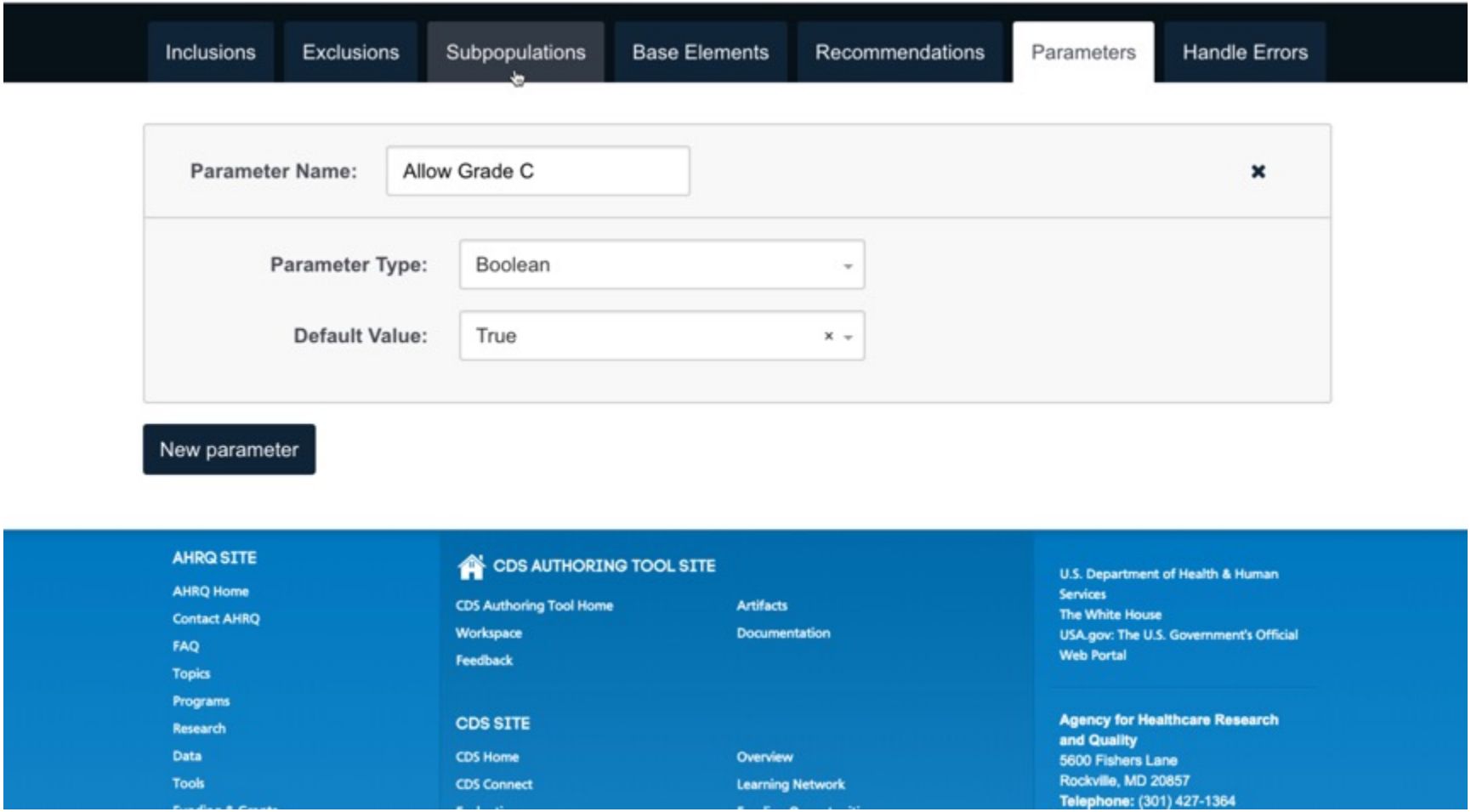
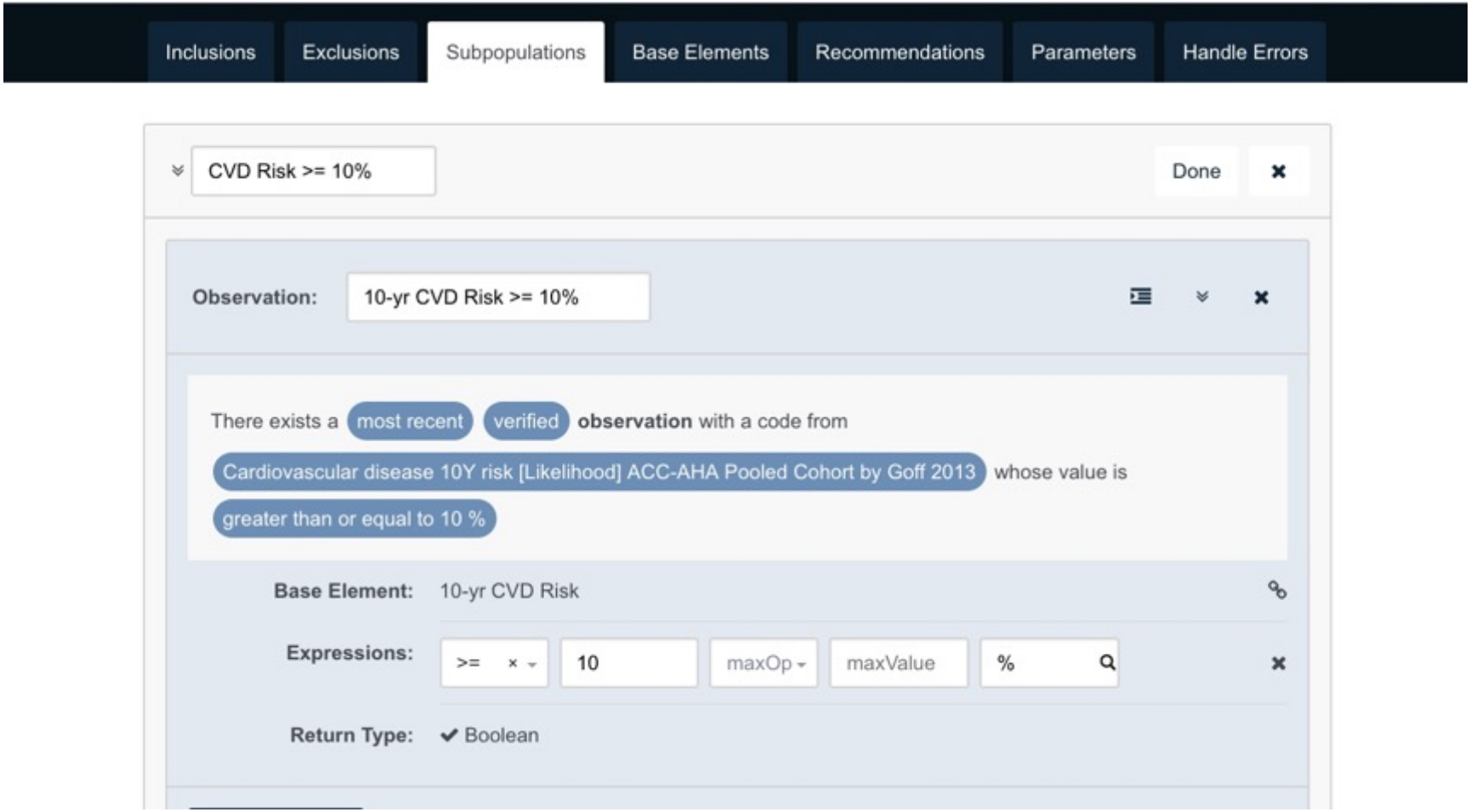
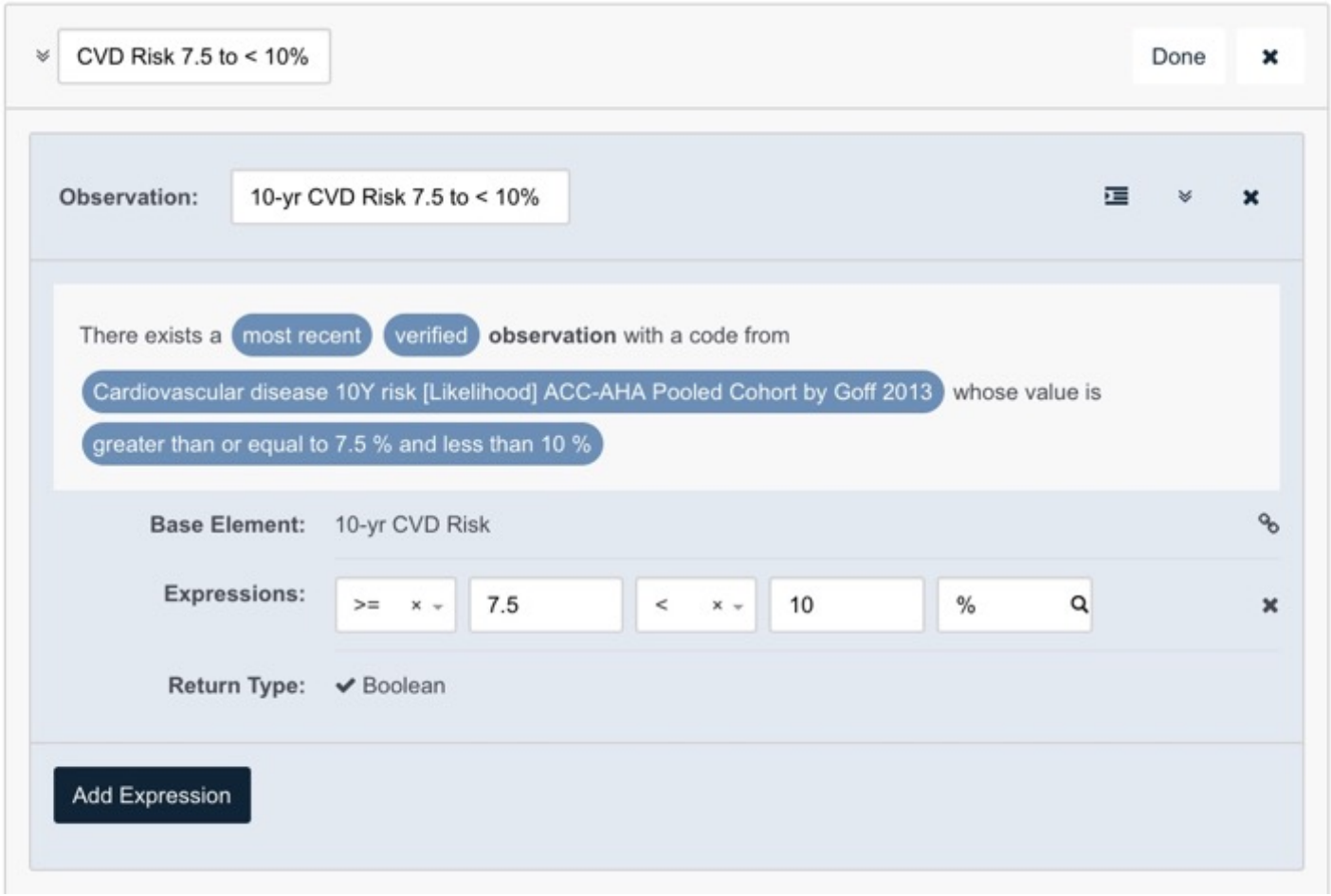


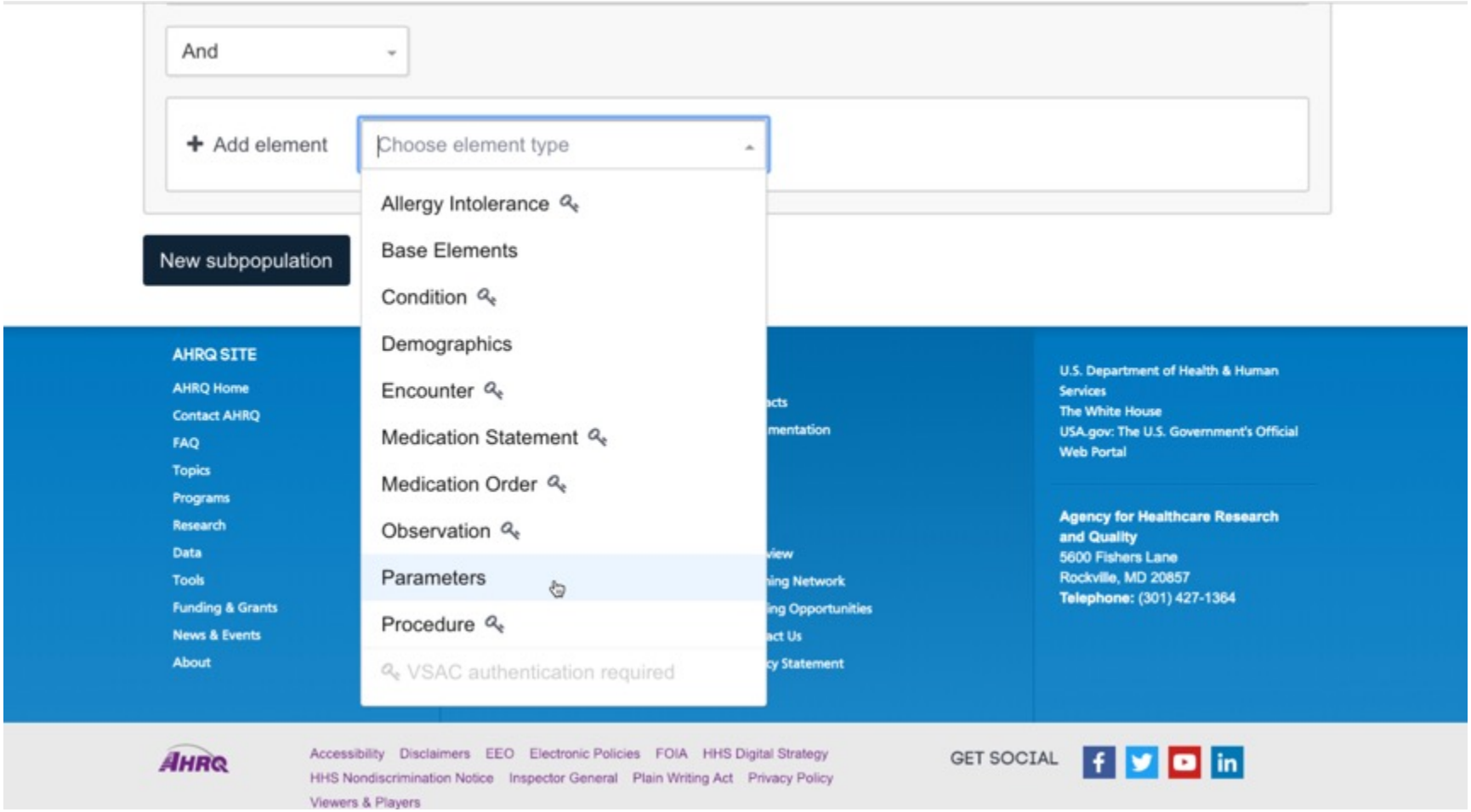
CDS Authoring Tool: Parameters



CDS Authoring Tool: Parameters



CDS Authoring Tool: Parameters



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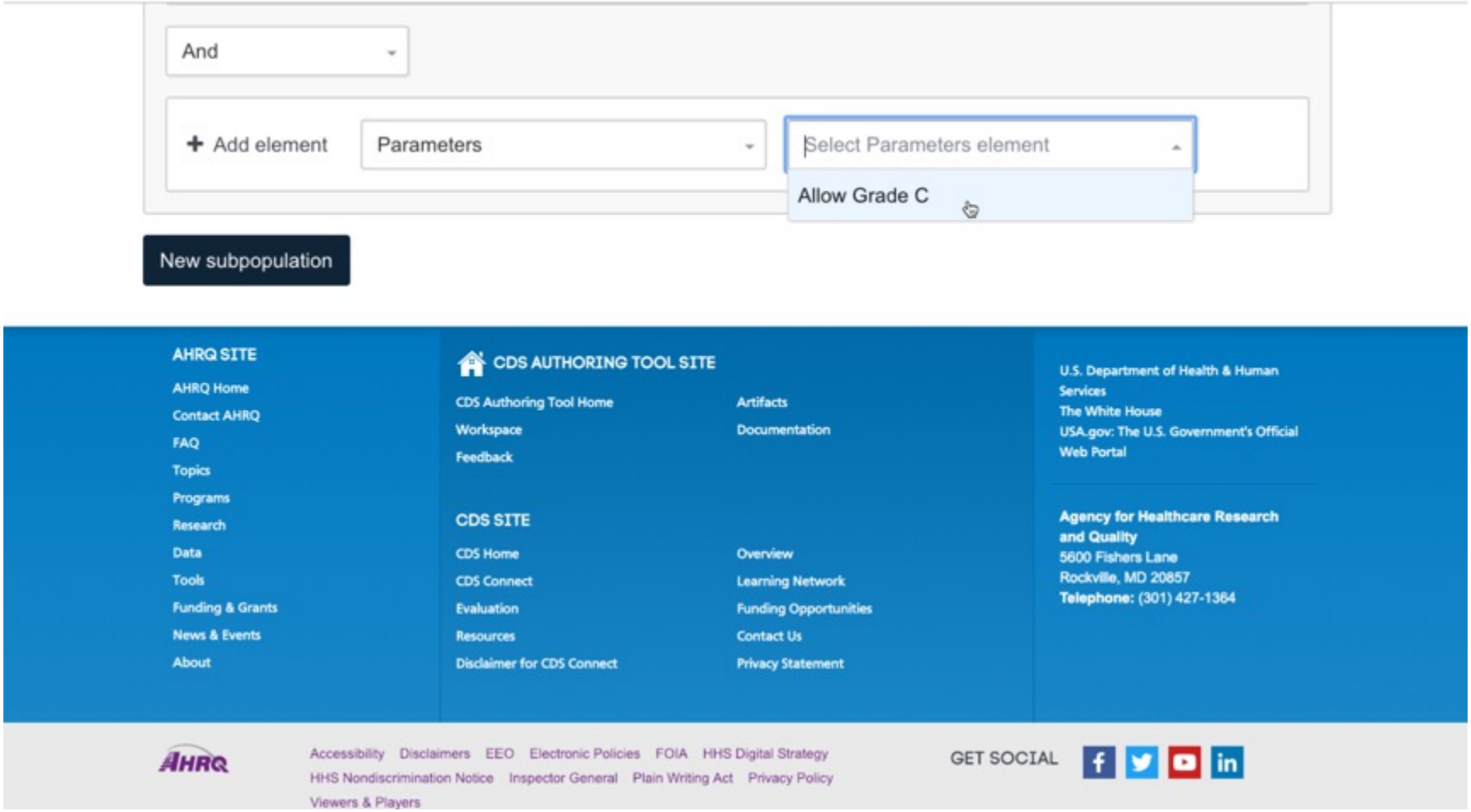

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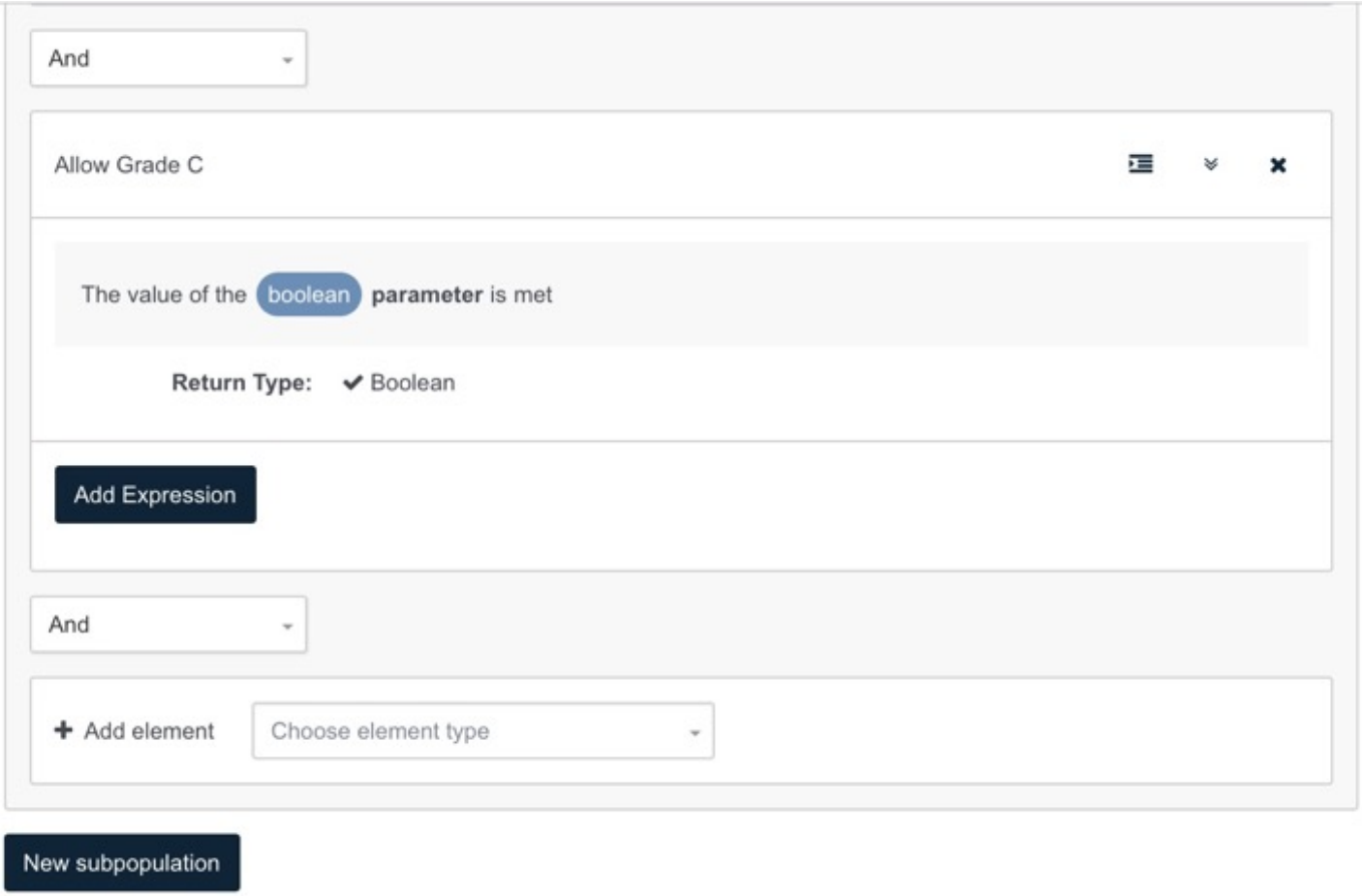
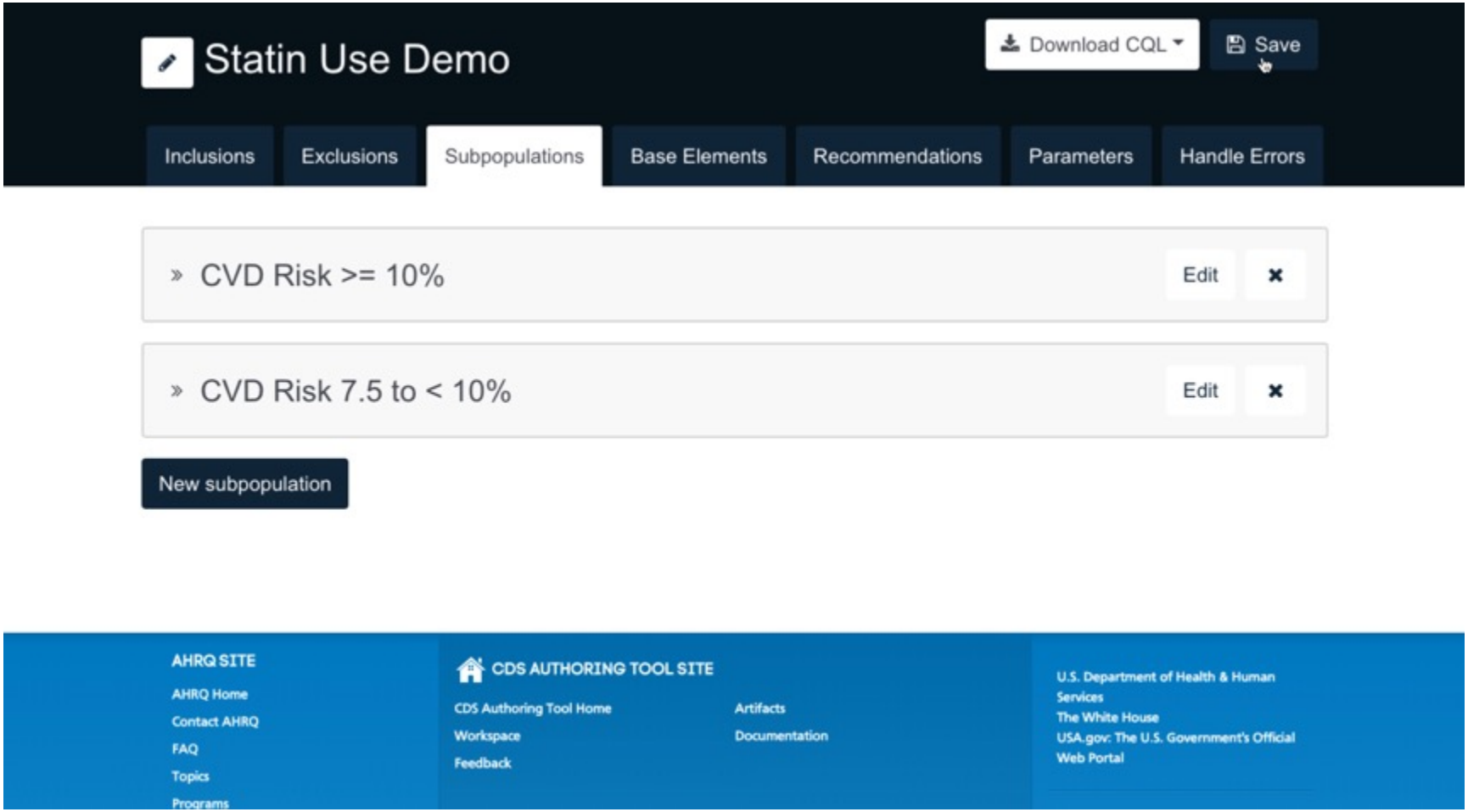


CDS Authoring Tool: Save



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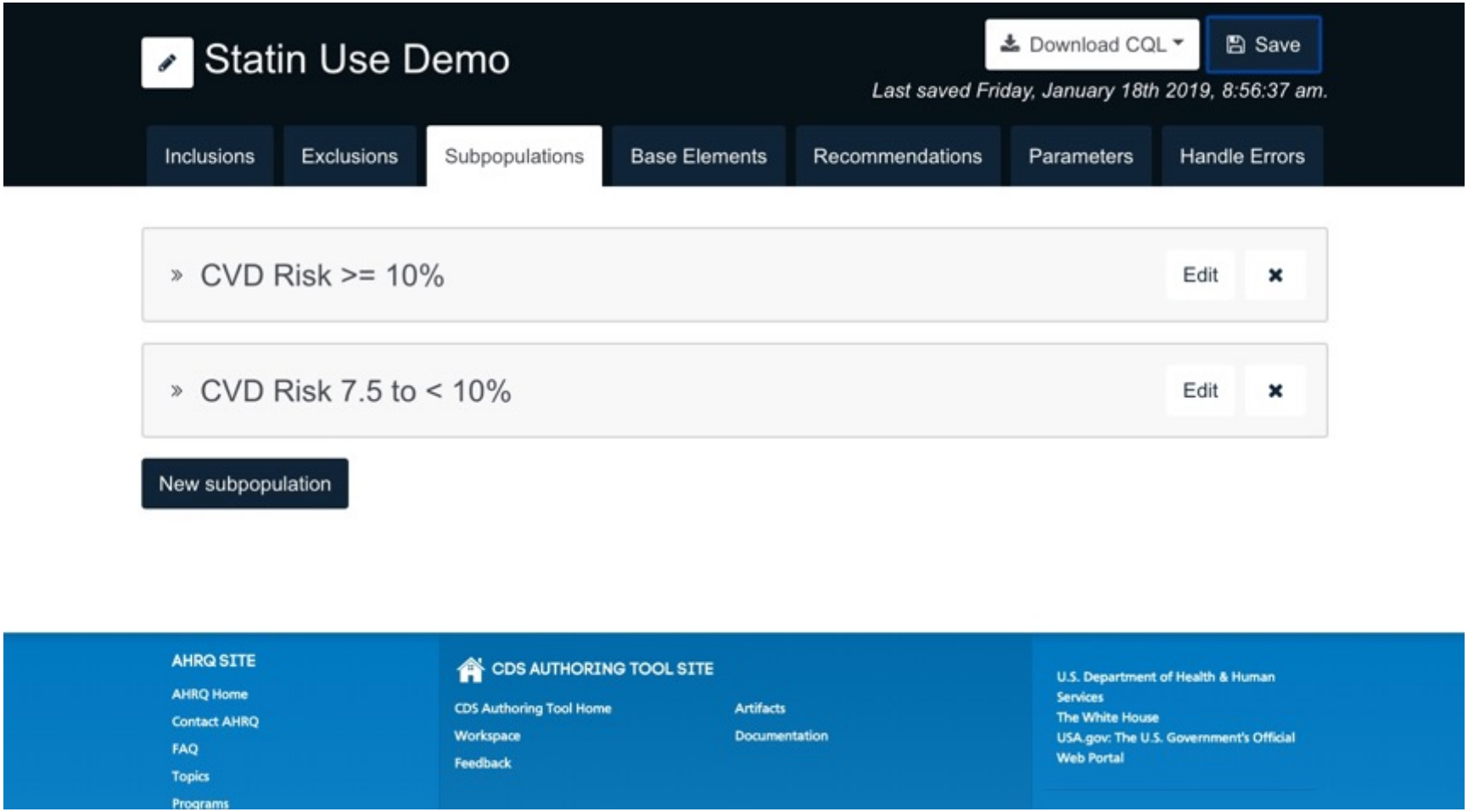
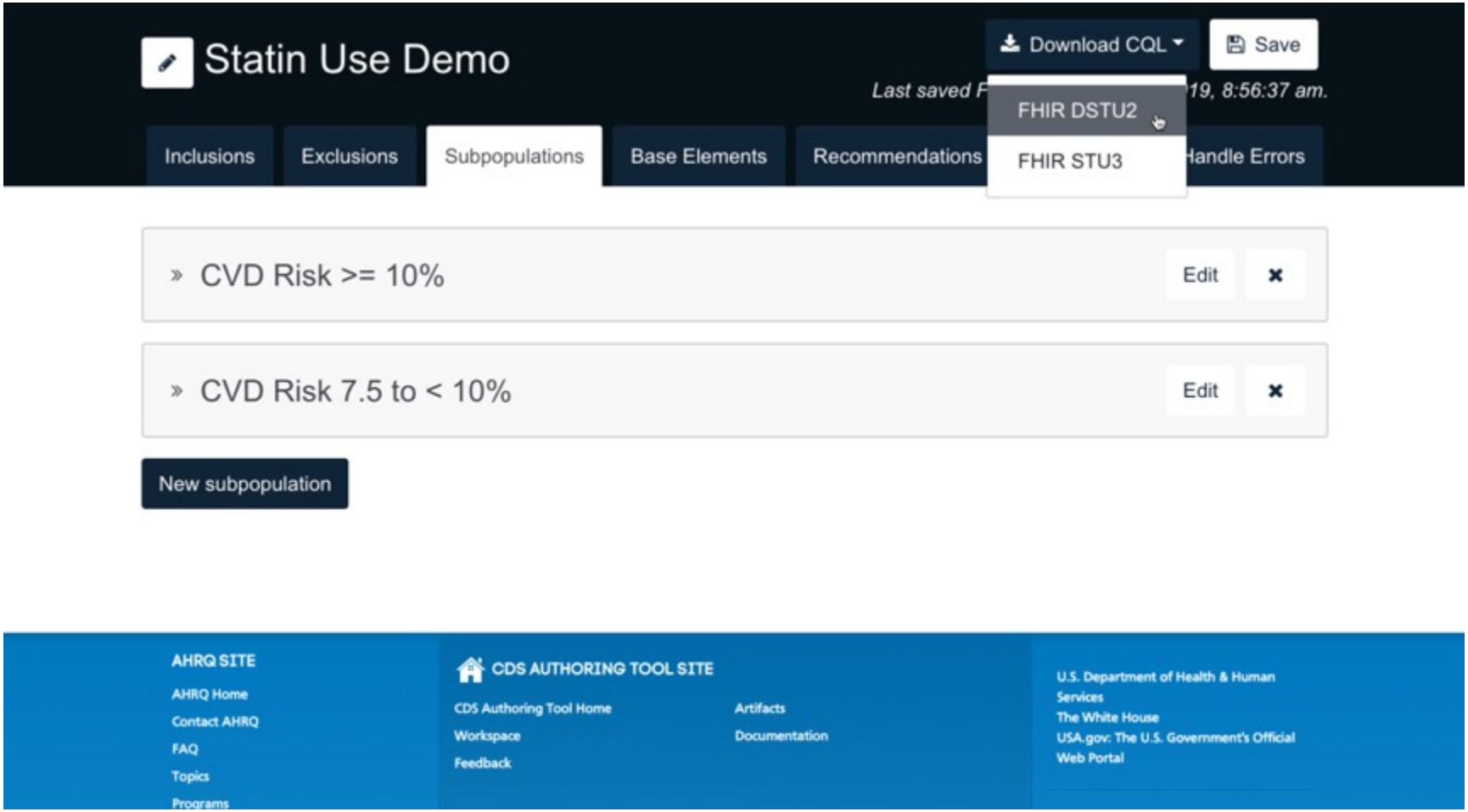


CDS Authoring Tool: Download



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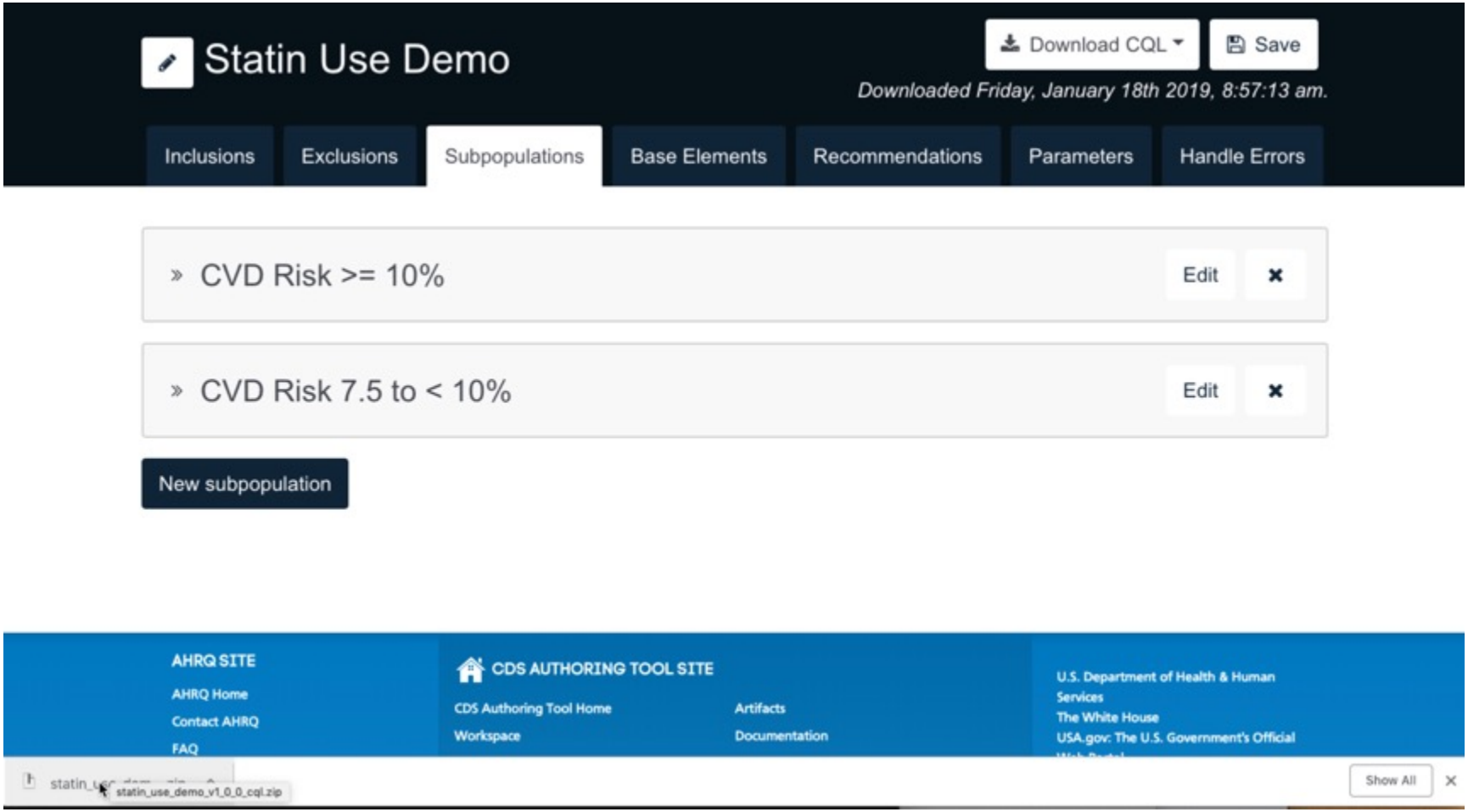

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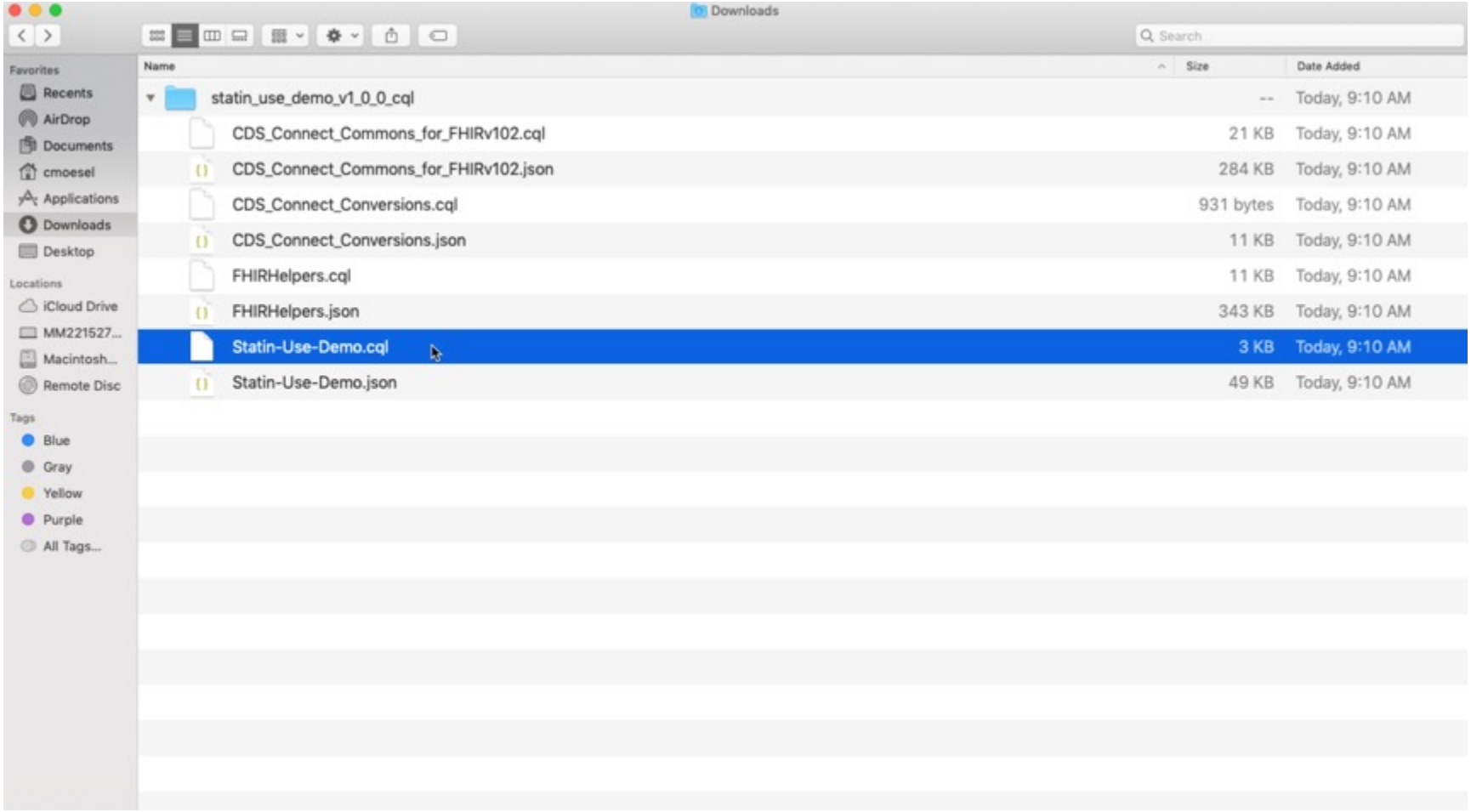

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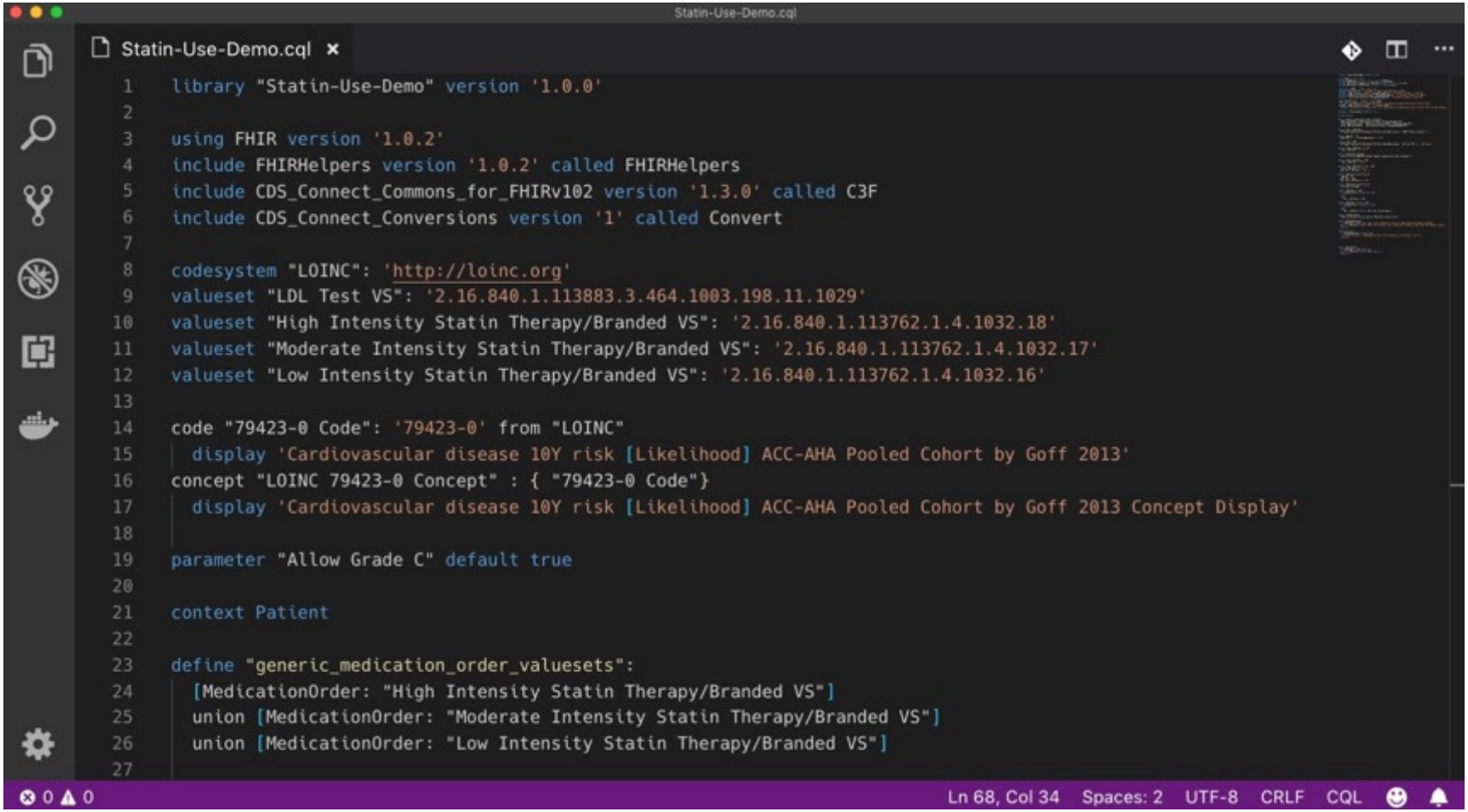

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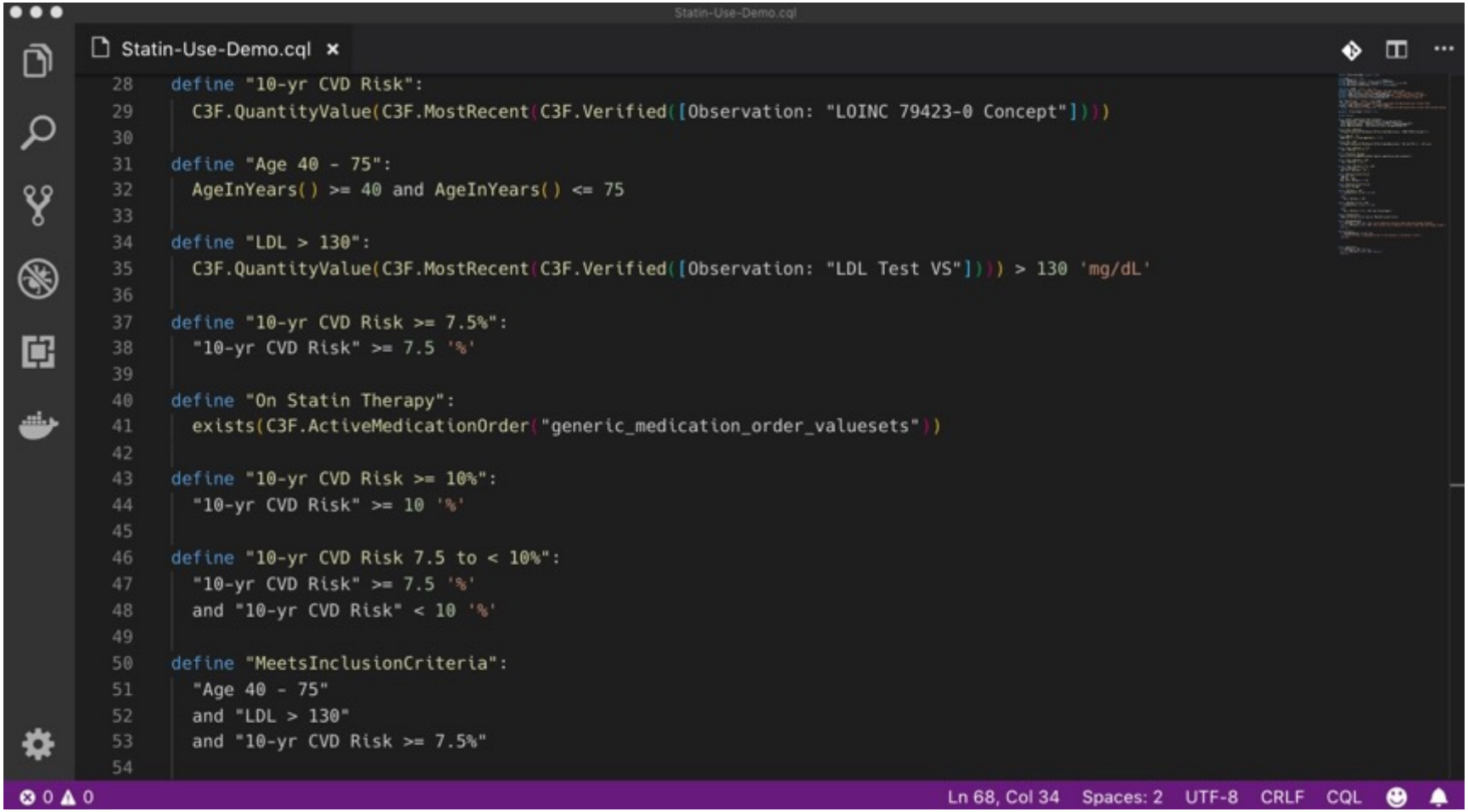

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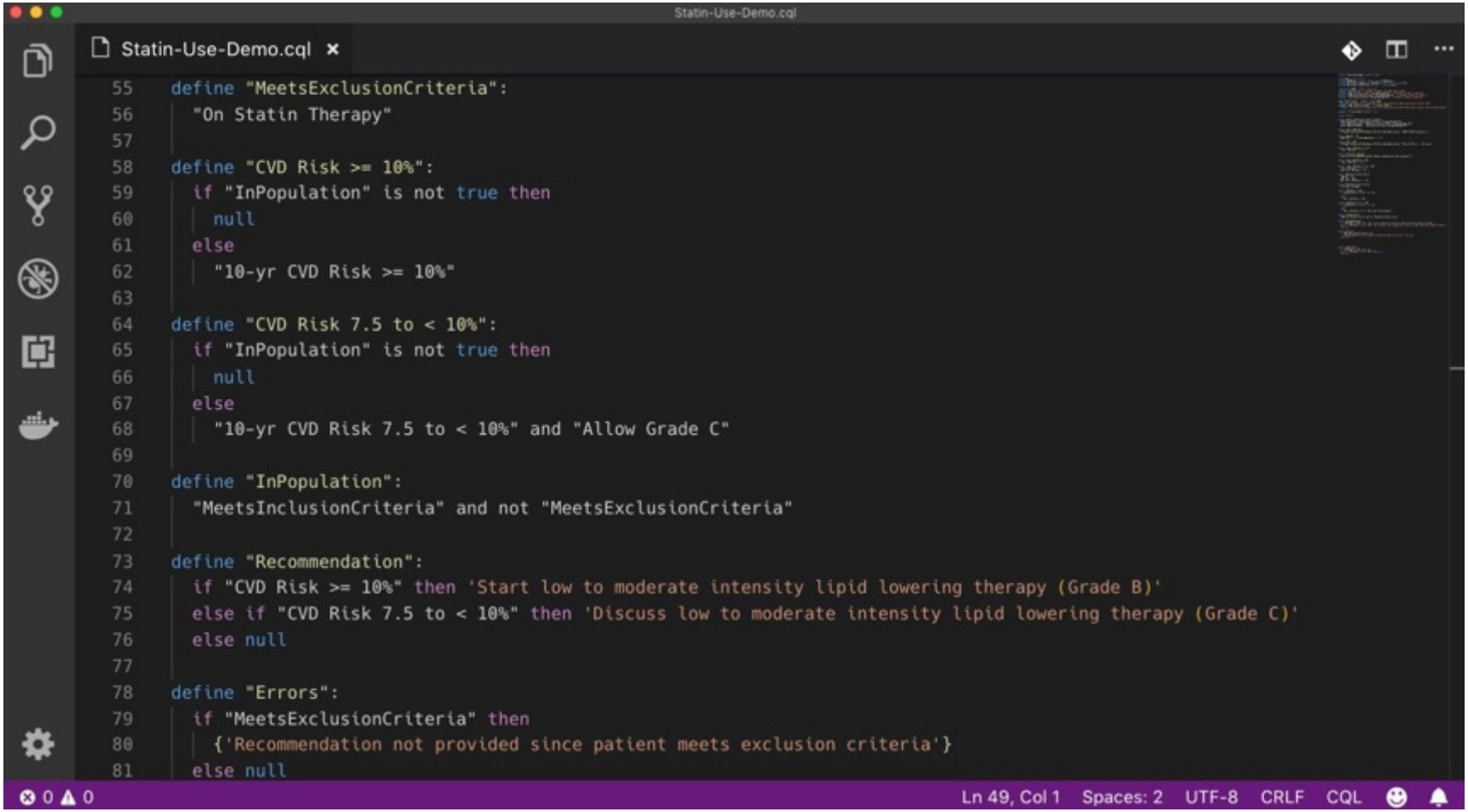
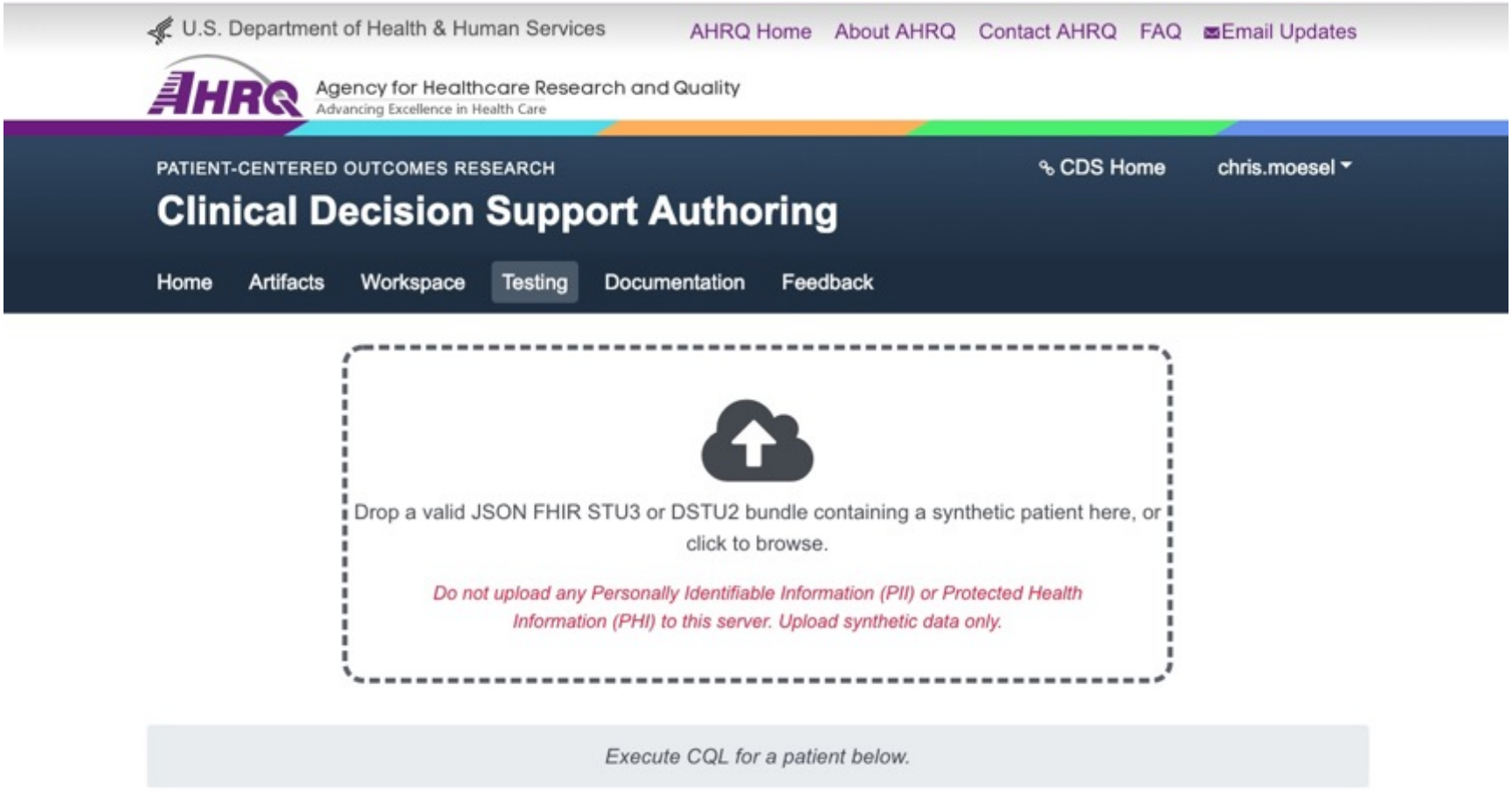
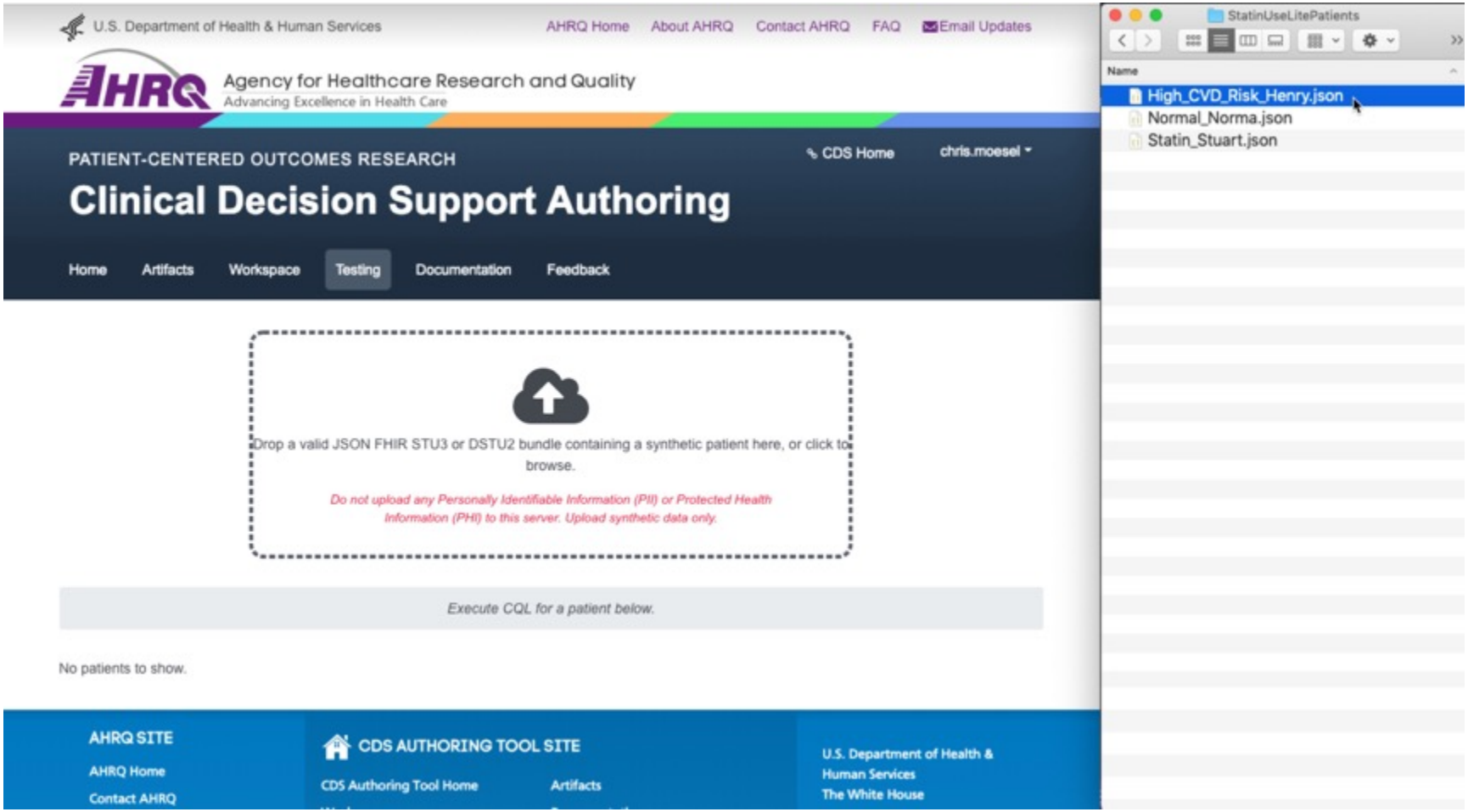


CDS Authoring Tool: Testing



CDS Authoring Tool: Testing



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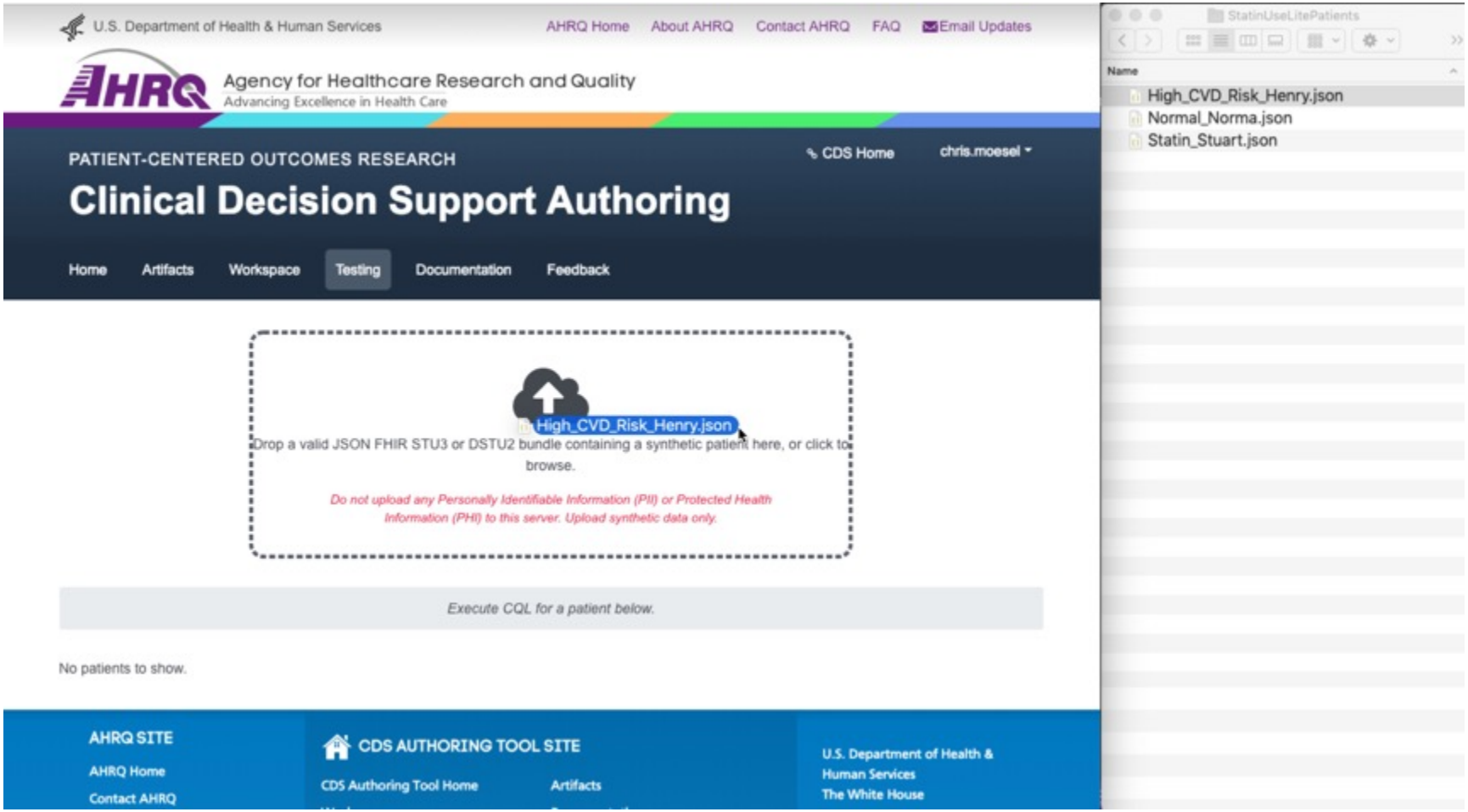

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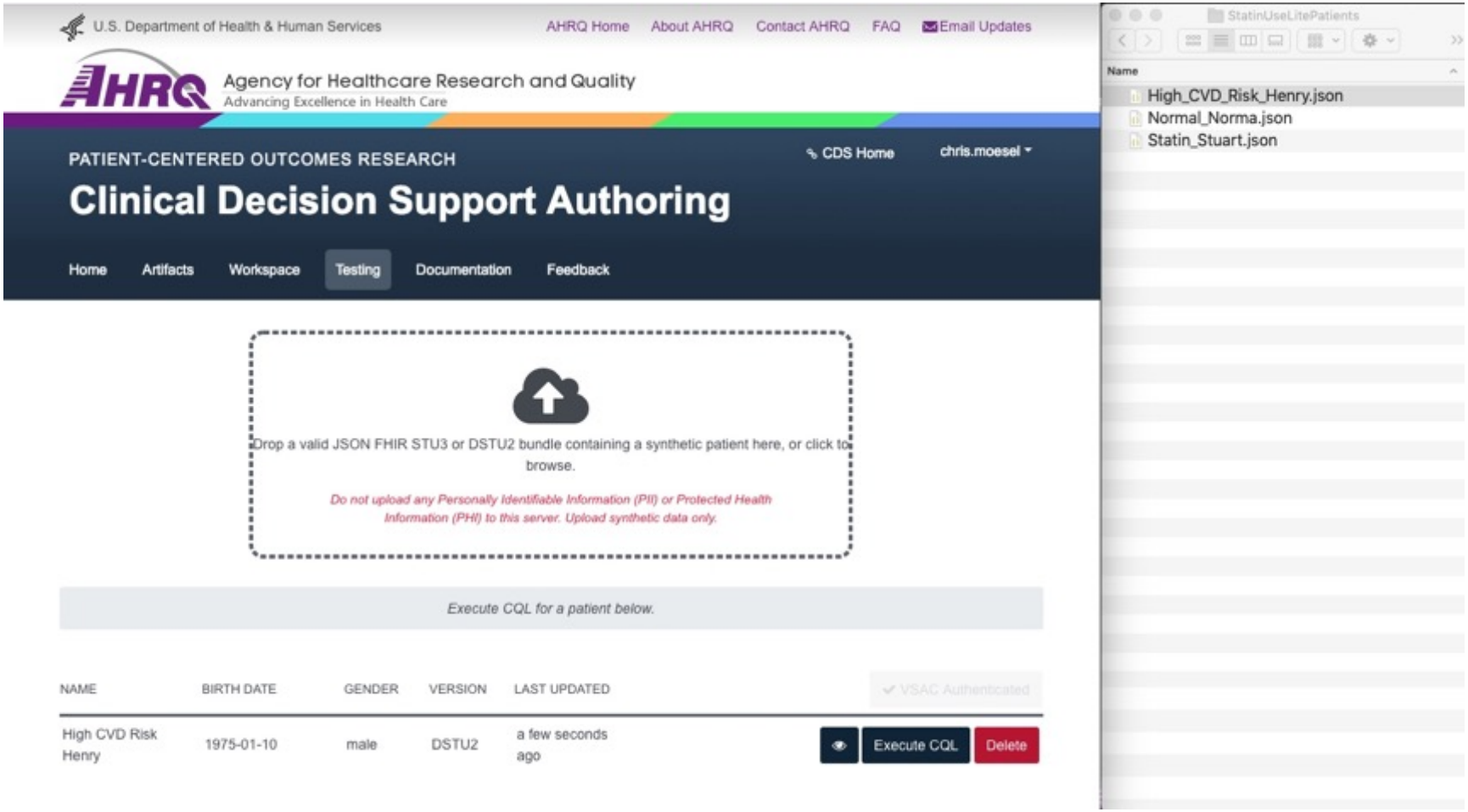

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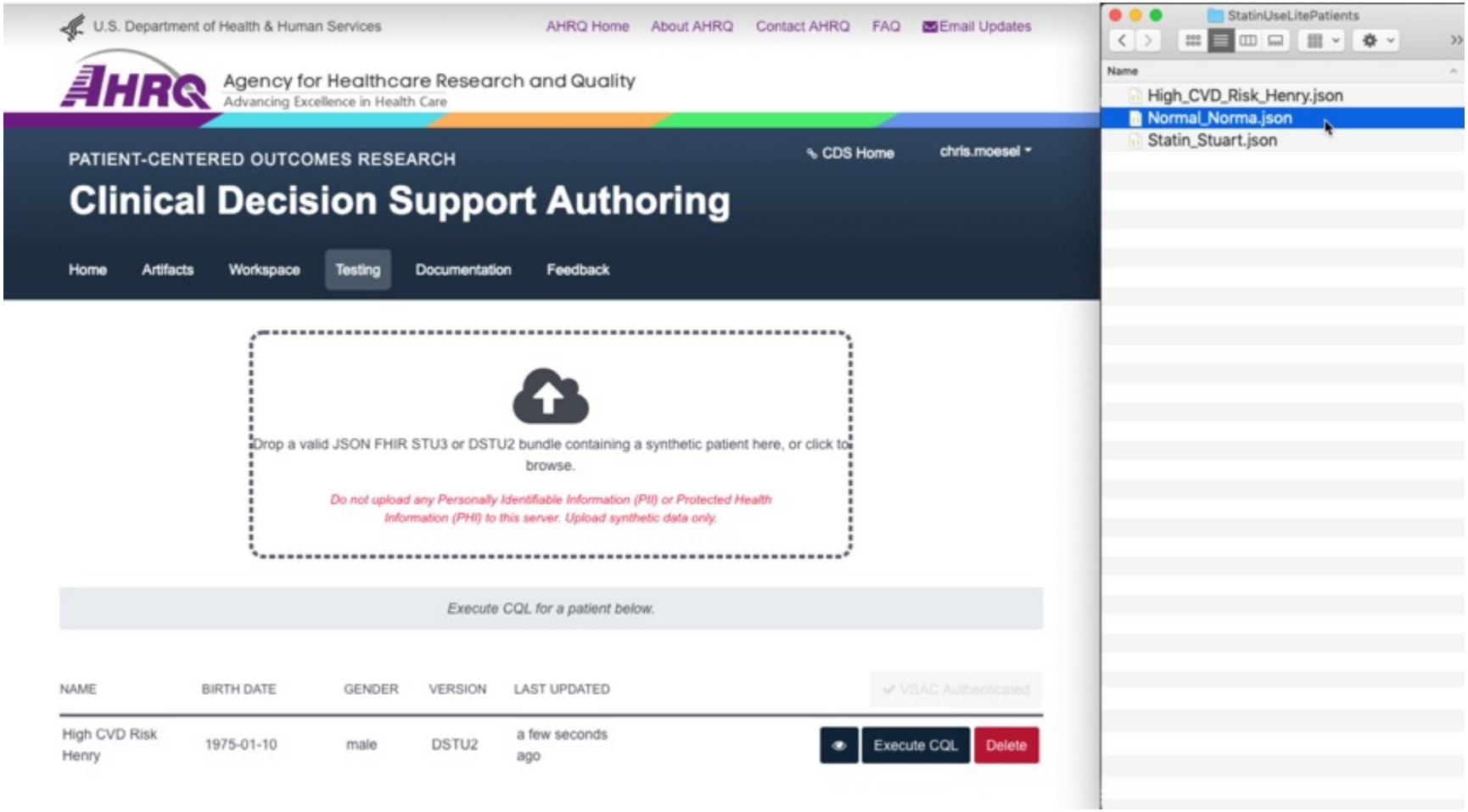

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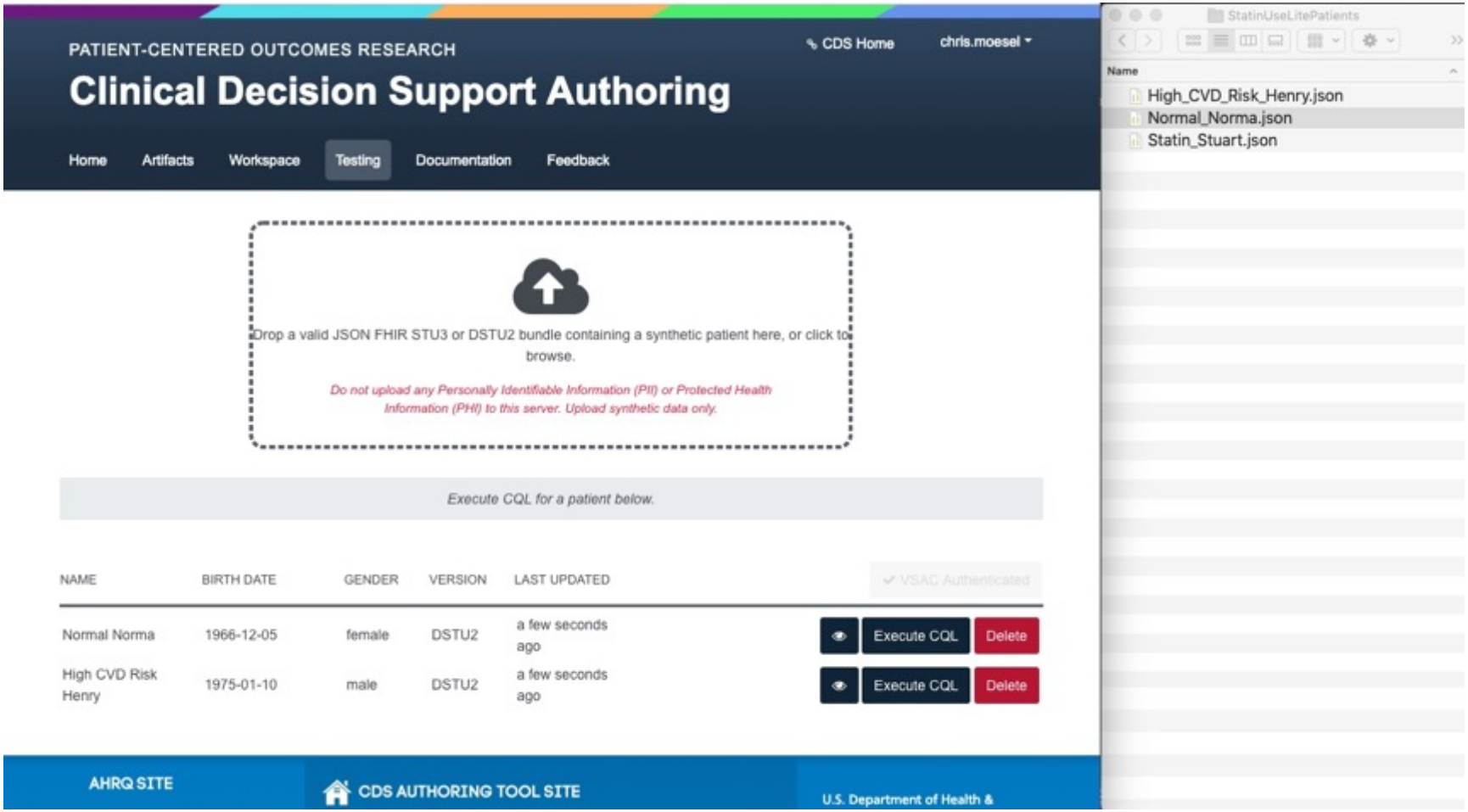

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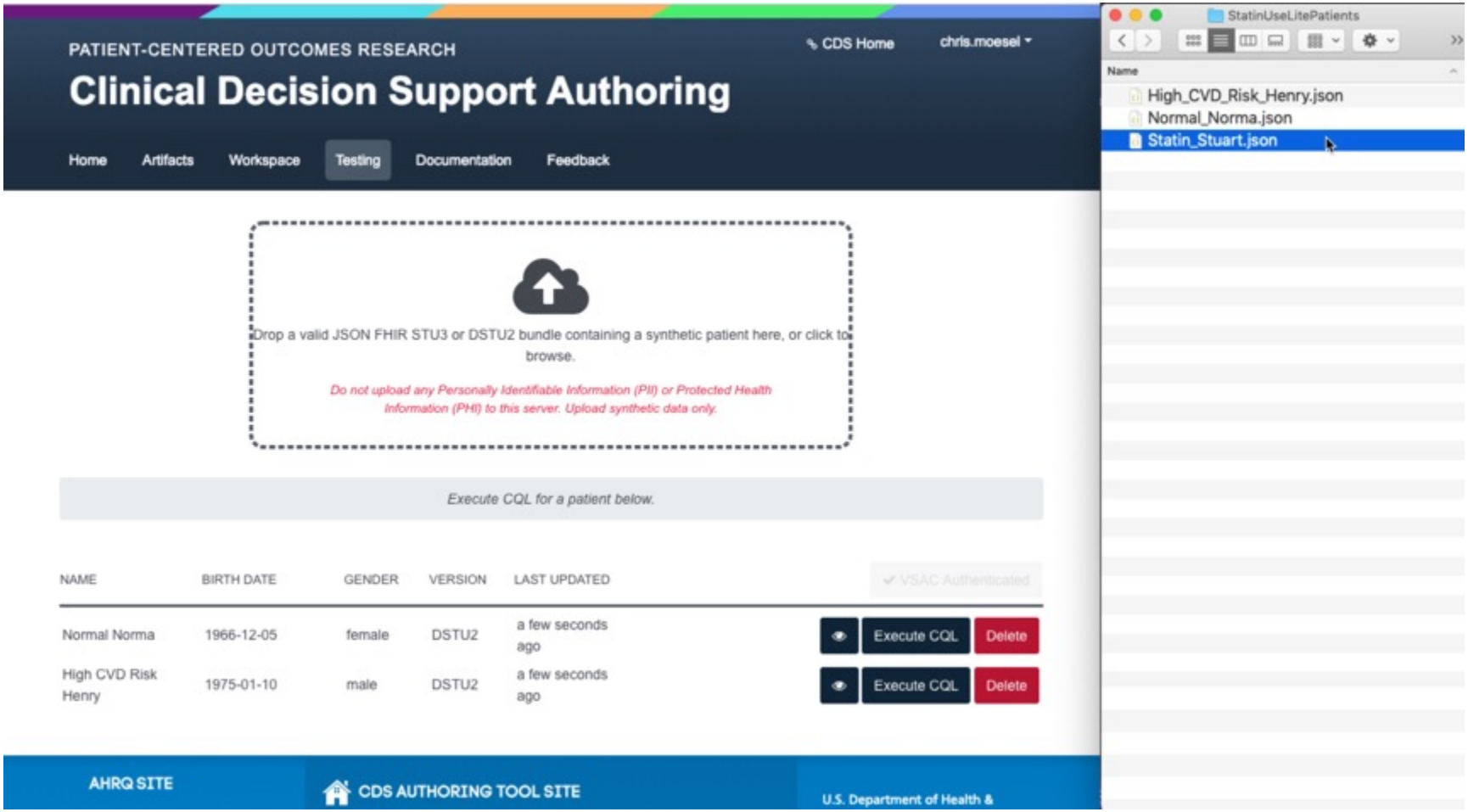

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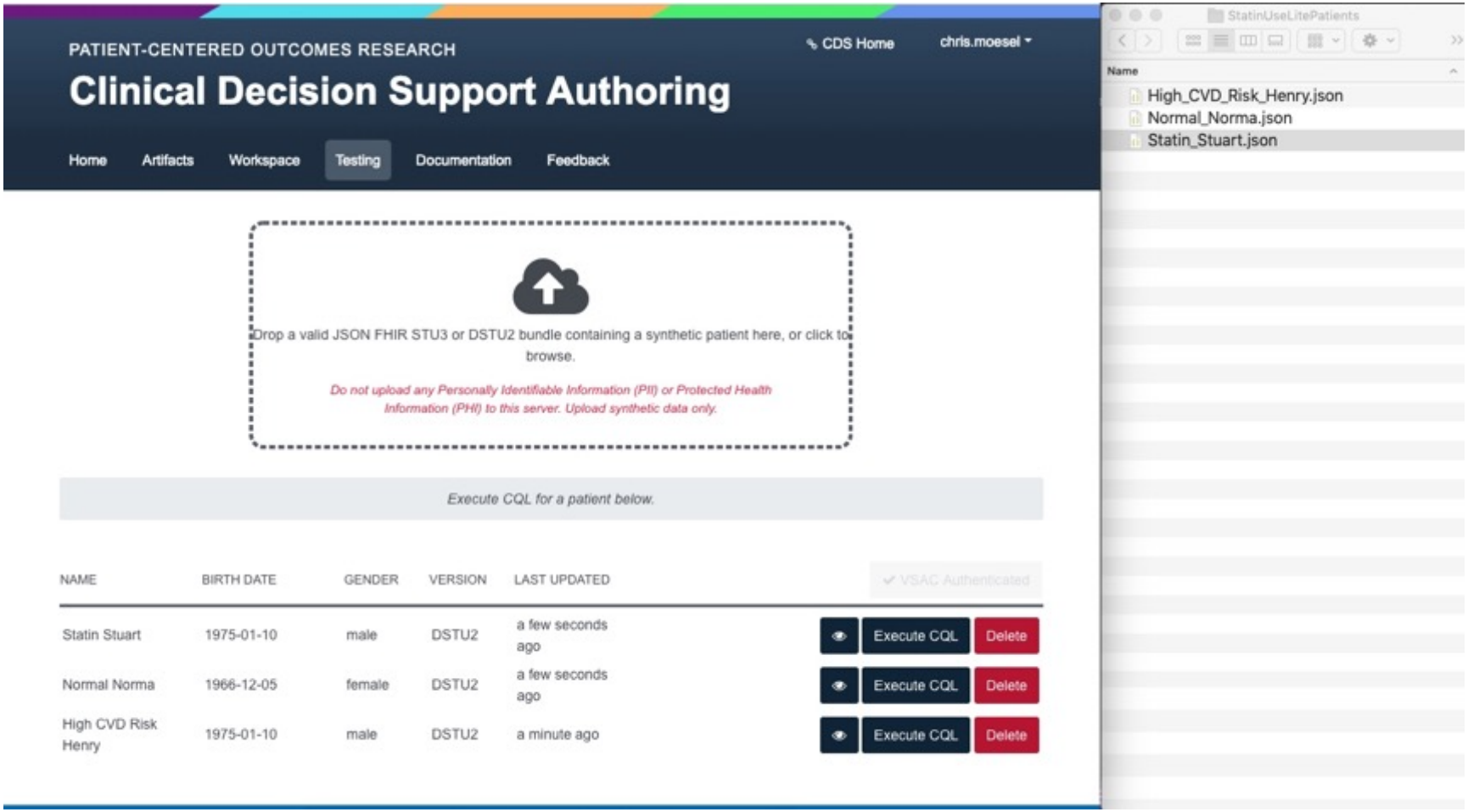

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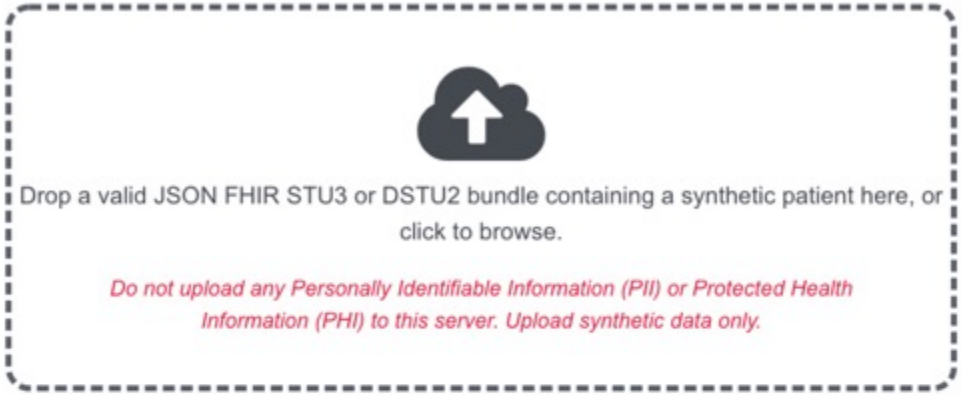
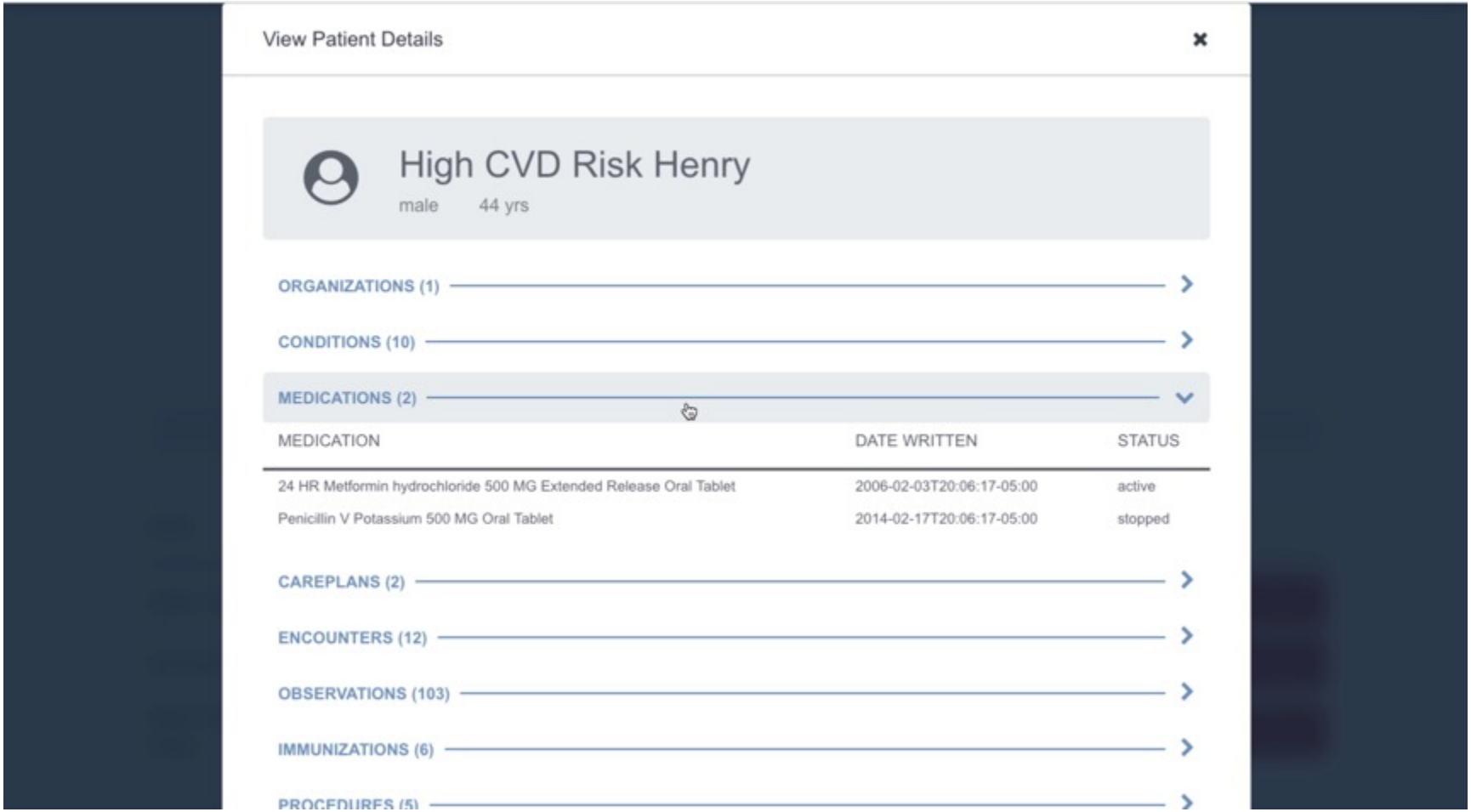


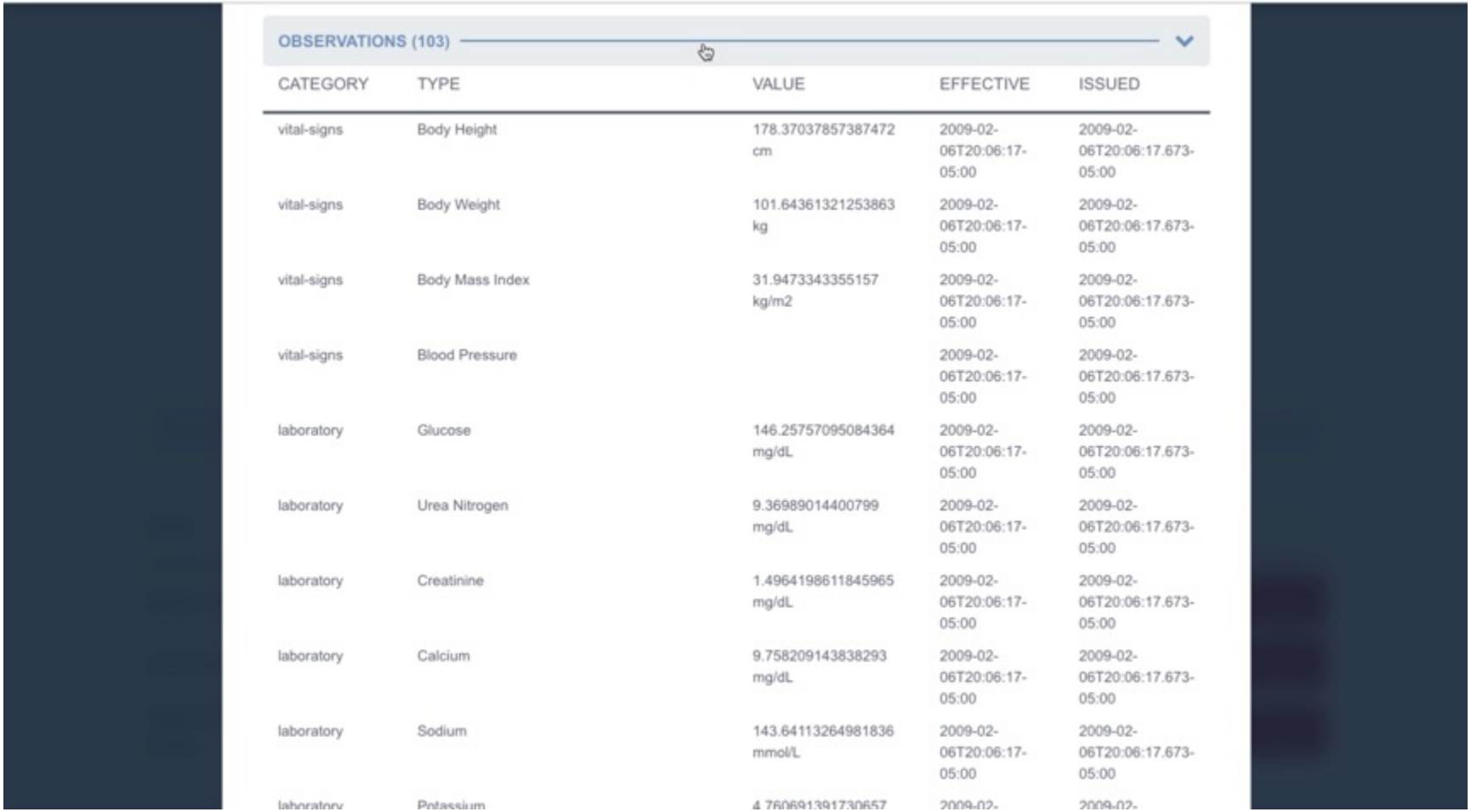
Execute CQL for a patient below.

NAME	BIRTH DATE	GENDER	VERSION	LAST UPDATED	✔ VSAC Authenticated
Statin Stuart	1975-01-10	male	DSTU2	a few seconds ago	Execute CQL Delete
Normal Norma	1966-12-05	female	DSTU2	a few seconds ago	Execute CQL Delete
High CVD Risk Henry	1975-01-10	male	DSTU2	a minute ago	Execute CQL Delete

CDS Authoring Tool: Testing



CDS Authoring Tool: Testing



OBSERVATIONS (103)

CATEGORY	TYPE	VALUE	EFFECTIVE	ISSUED
vital-signs	Body Height	178.37037857387472 cm	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
vital-signs	Body Weight	101.64361321253863 kg	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
vital-signs	Body Mass Index	31.9473343355157 kg/m2	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
vital-signs	Blood Pressure		2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
laboratory	Glucose	146.25757095084364 mg/dL	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
laboratory	Urea Nitrogen	9.36989014400799 mg/dL	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
laboratory	Creatinine	1.4964198611845965 mg/dL	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
laboratory	Calcium	9.758209143838293 mg/dL	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
laboratory	Sodium	143.64113264981836 mmol/L	2009-02-06T20:06:17-05:00	2009-02-06T20:06:17.673-05:00
laboratory	Potassium	4.760691391730657	2009-02-	2009-02-

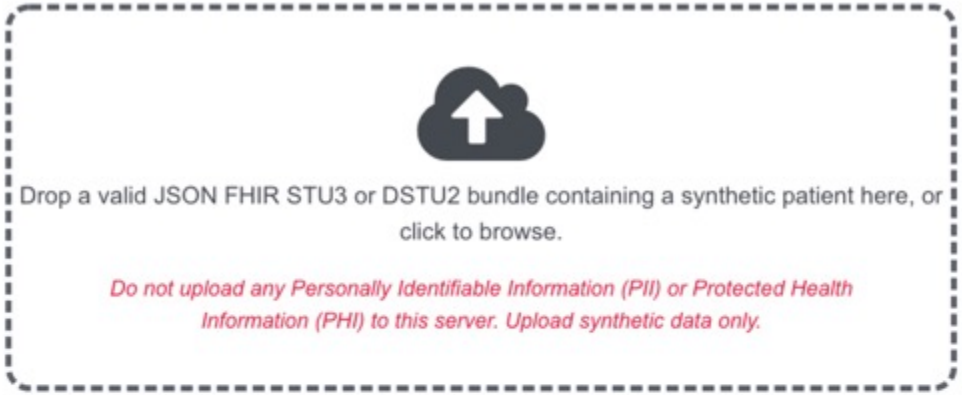
CDS Authoring Tool: Testing

		mmol/L	09T20:06:17-05:00	09T20:06:17.673-05:00
laboratory	Carbon Dioxide	23.414943814025904 mmol/L	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Total Cholesterol	217.18908248696656 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Triglycerides	153.3957157685174 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Low Density Lipoprotein Cholesterol	136.44788940072107 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	High Density Lipoprotein Cholesterol	50.06204993254201 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Microalbumin Creatinine Ratio	2.9903271073954496 mg/g	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Estimated Glomerular Filtration Rate	87.73260513711118 mL/min/{1.73_m2}	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
survey	Tobacco smoking status NHIS	Current every day smoker	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
procedure	Cardiovascular disease 10Y risk [Likelihood] ACC-AHA Pooled Cohort by Goff 2013	15.5 %	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Hemoglobin A1c/Hemoglobin.total in Blood	7.596367505946317 %	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00

CDS Authoring Tool: Testing

		mmol/L	09T20:06:17-05:00	09T20:06:17.673-05:00
laboratory	Carbon Dioxide	23.414943814025904 mmol/L	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Total Cholesterol	217.18908248696656 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Triglycerides	153.3957157685174 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Low Density Lipoprotein Cholesterol	136.44788940072107 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	High Density Lipoprotein Cholesterol	50.06204993254201 mg/dL	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Microalbumin Creatinine Ratio	2.9903271073954496 mg/g	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Estimated Glomerular Filtration Rate	87.73260513711118 mL/min/{1.73_m2}	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
survey	Tobacco smoking status NHIS	Current every day smoker	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
procedure	Cardiovascular disease 10Y risk [Likelihood] ACC-AHA Pooled Cohort by Goff 2013	15.5 %	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00
laboratory	Hemoglobin A1c/Hemoglobin.total in Blood	7.596367505946317 %	2018-03-09T20:06:17-05:00	2018-03-09T20:06:17.673-05:00

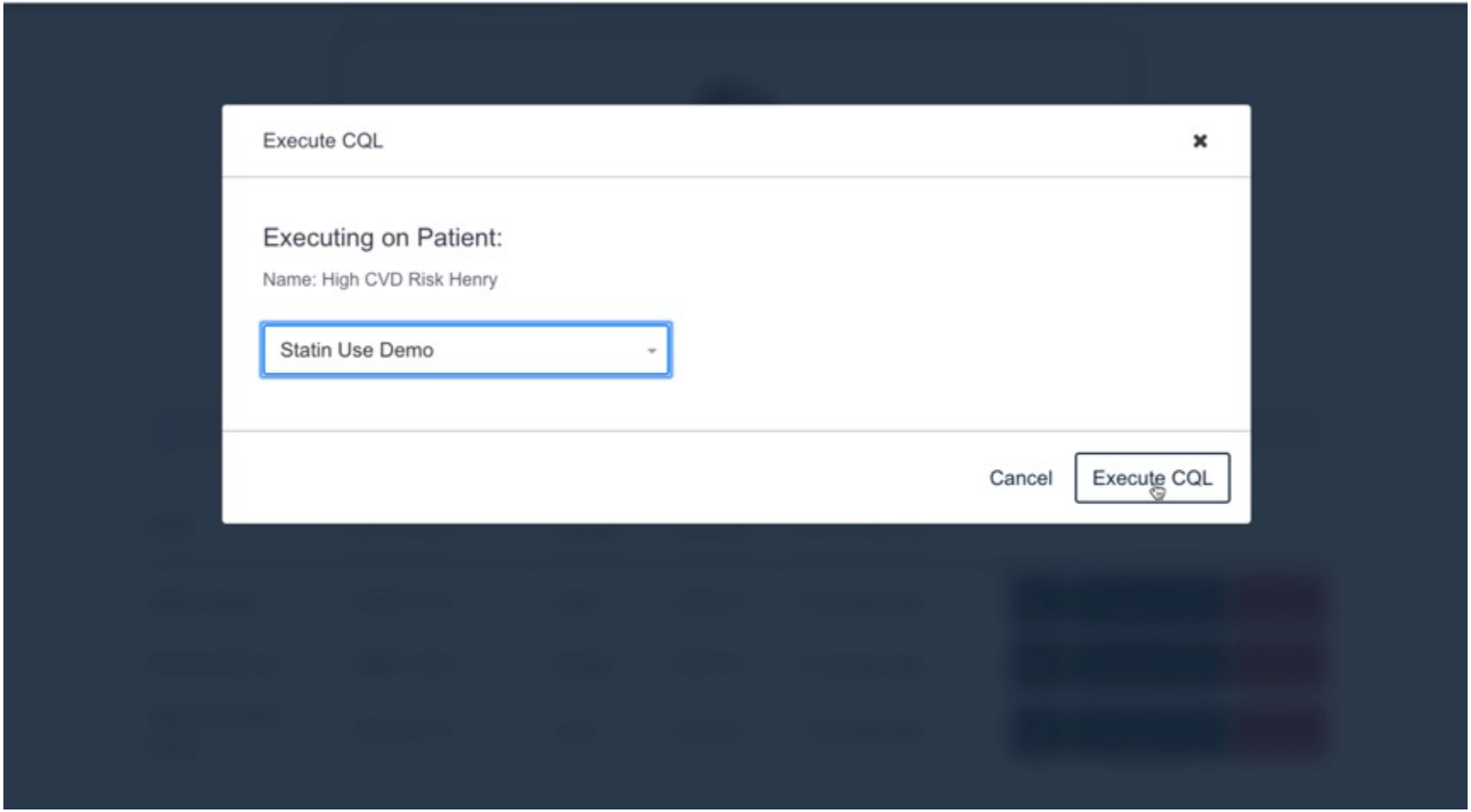
CDS Authoring Tool: Testing



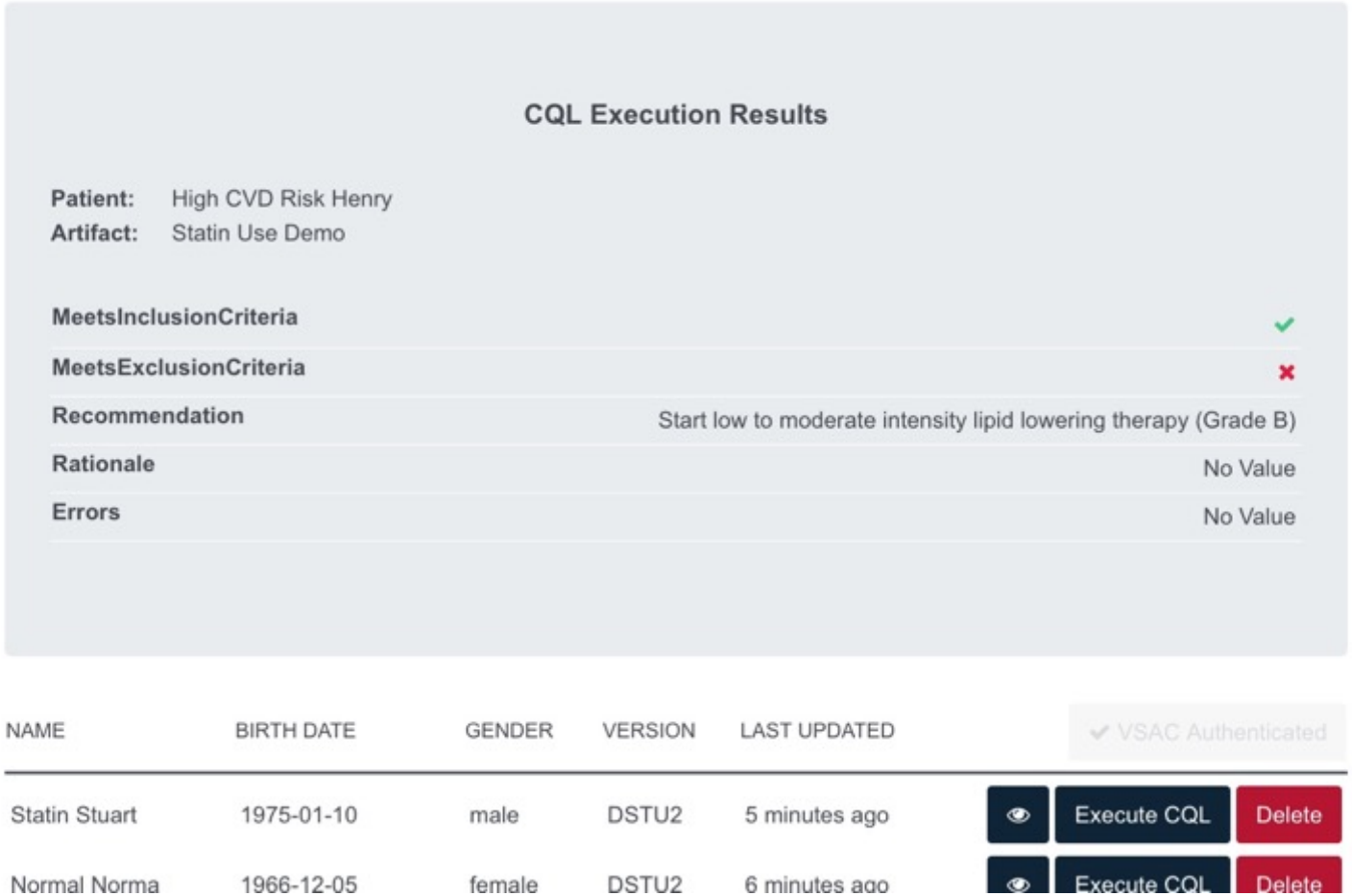
Execute CQL for a patient below.

NAME	BIRTH DATE	GENDER	VERSION	LAST UPDATED	✔ VSAC Authenticated
Statin Stuart	1975-01-10	male	DSTU2	5 minutes ago	Execute CQL Delete
Normal Norma	1966-12-05	female	DSTU2	6 minutes ago	Execute CQL Delete
High CVD Risk Henry	1975-01-10	male	DSTU2	6 minutes ago	Execute CQL Delete

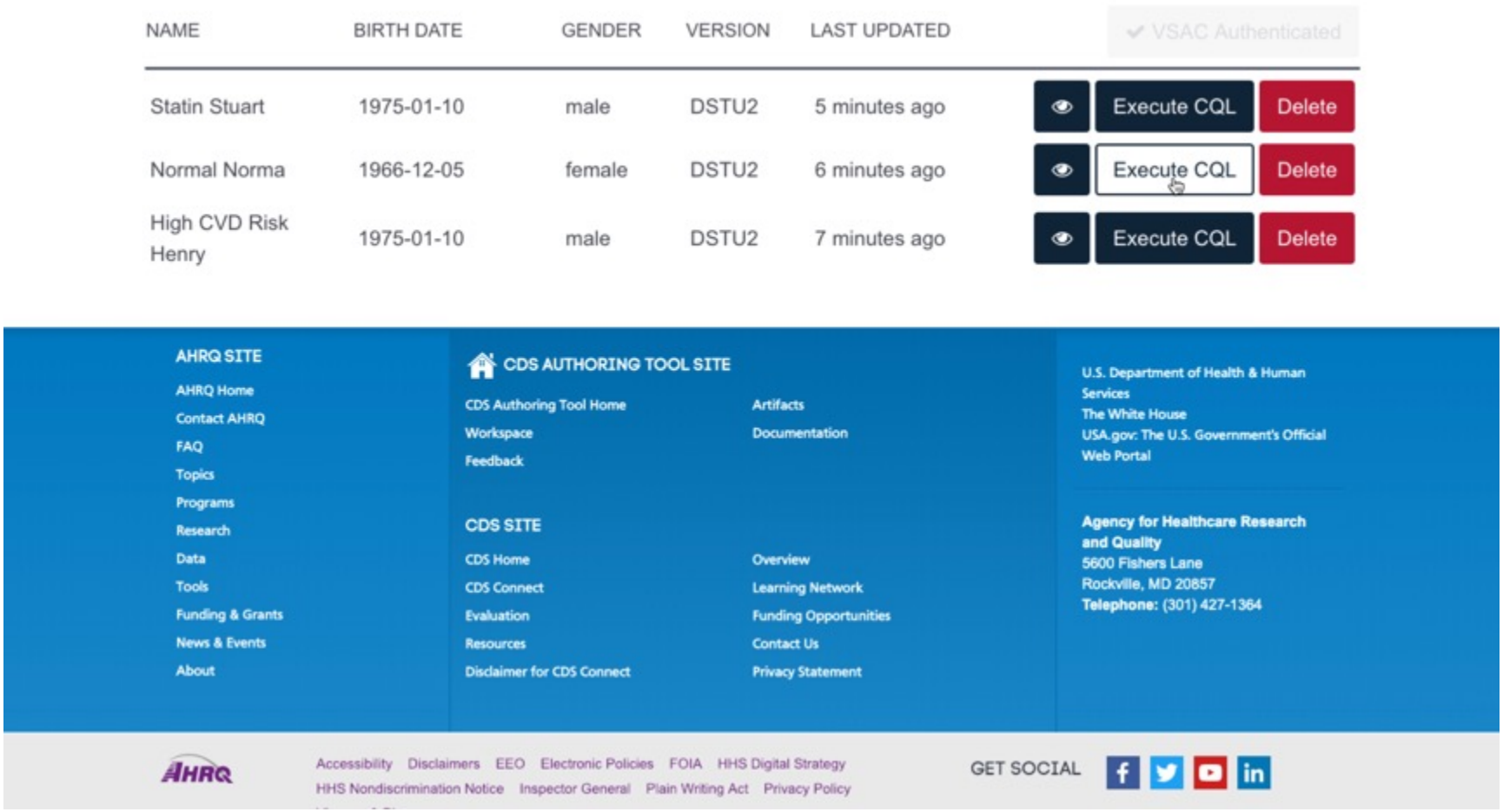
CDS Authoring Tool: Testing



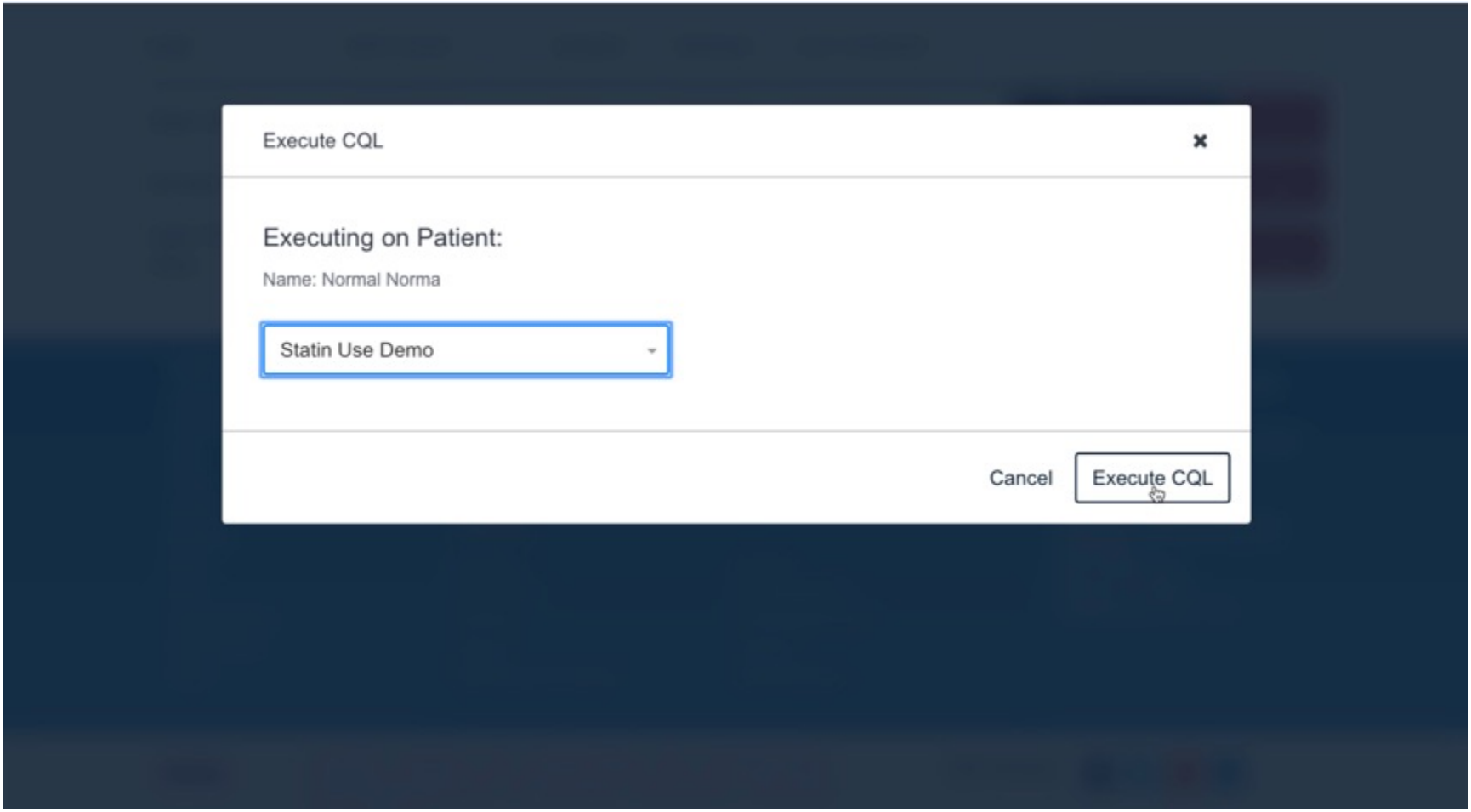
CDS Authoring Tool: Testing



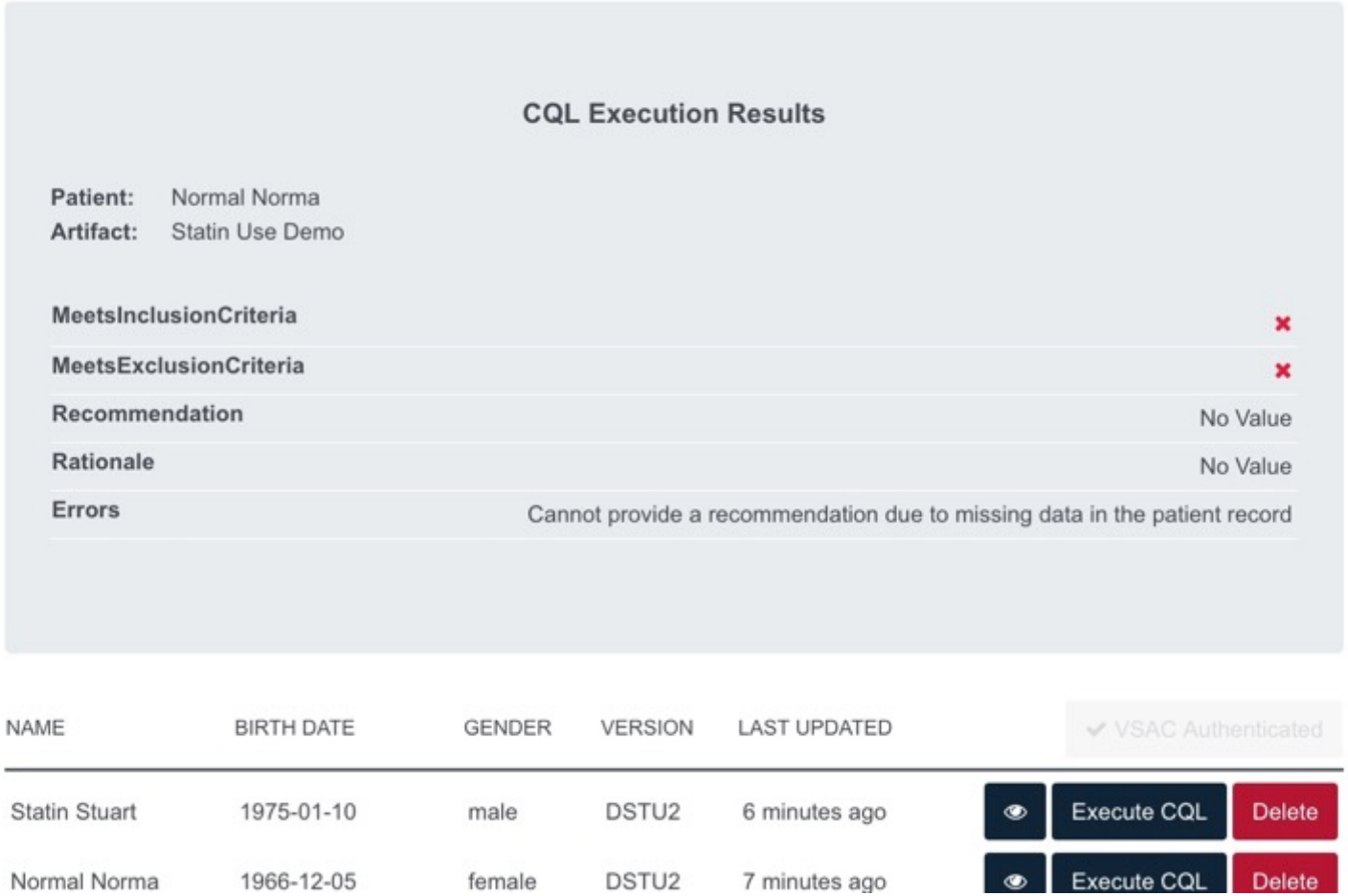
CDS Authoring Tool: Testing



CDS Authoring Tool: Testing



CDS Authoring Tool: Testing



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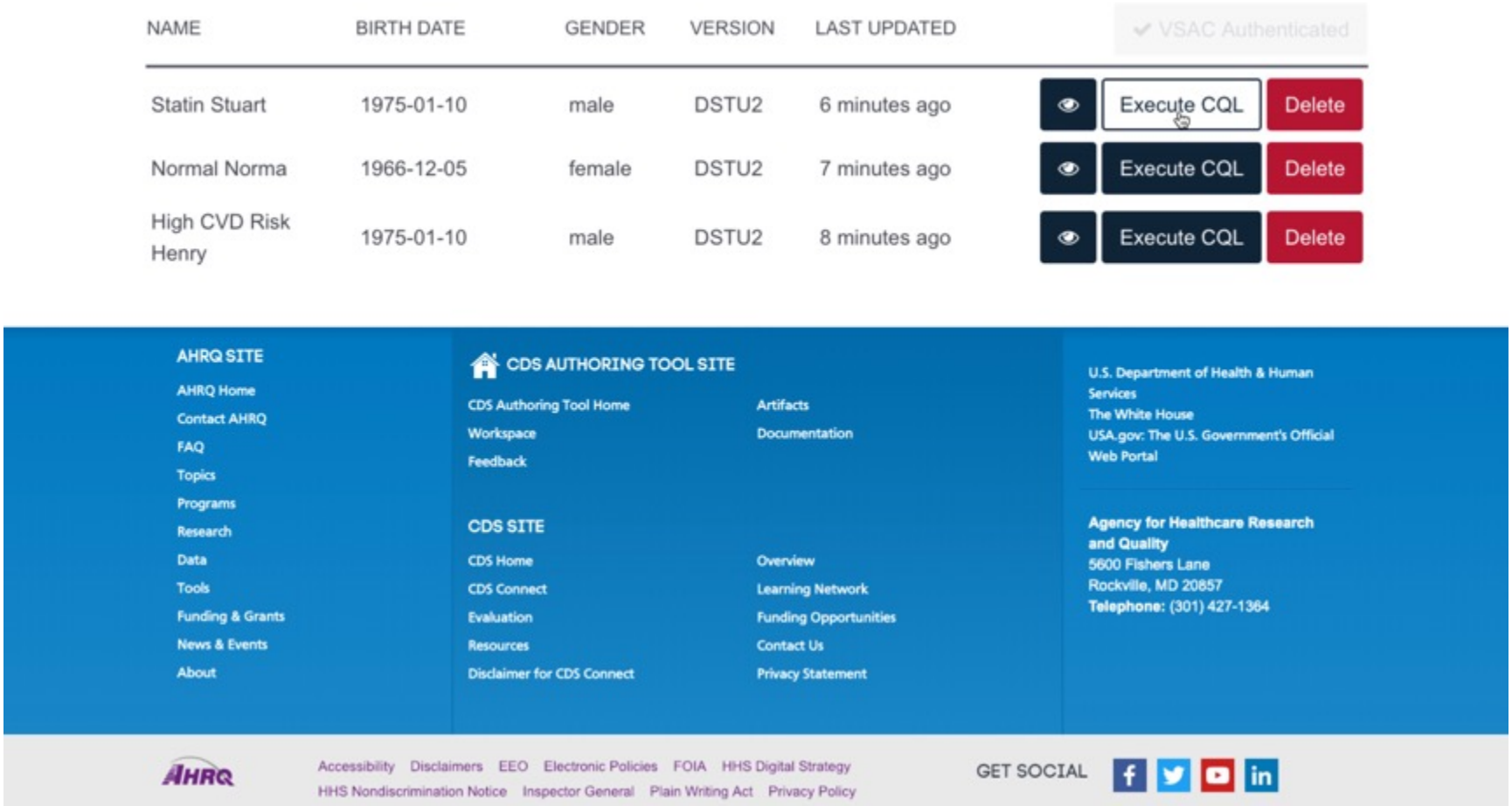

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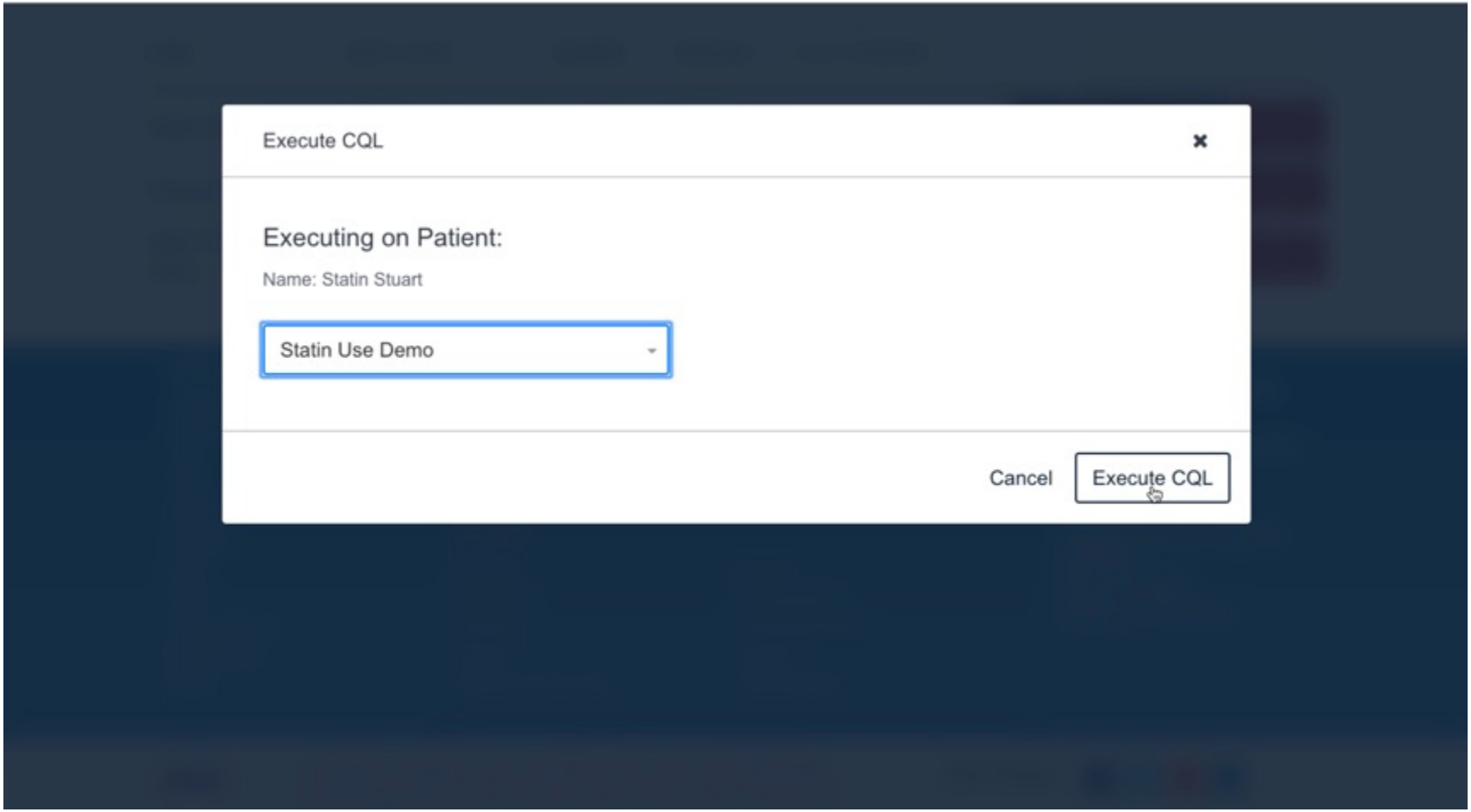
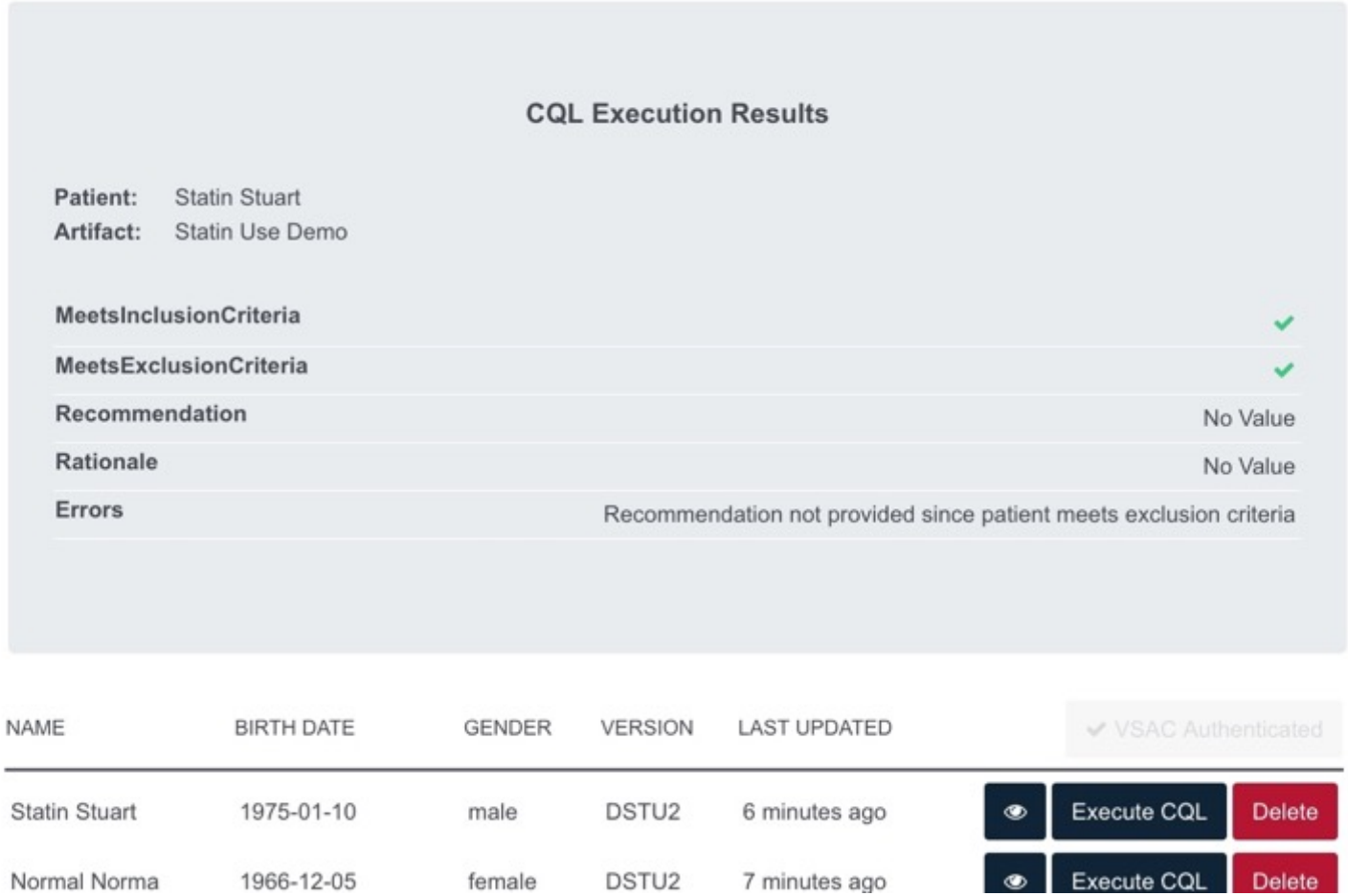
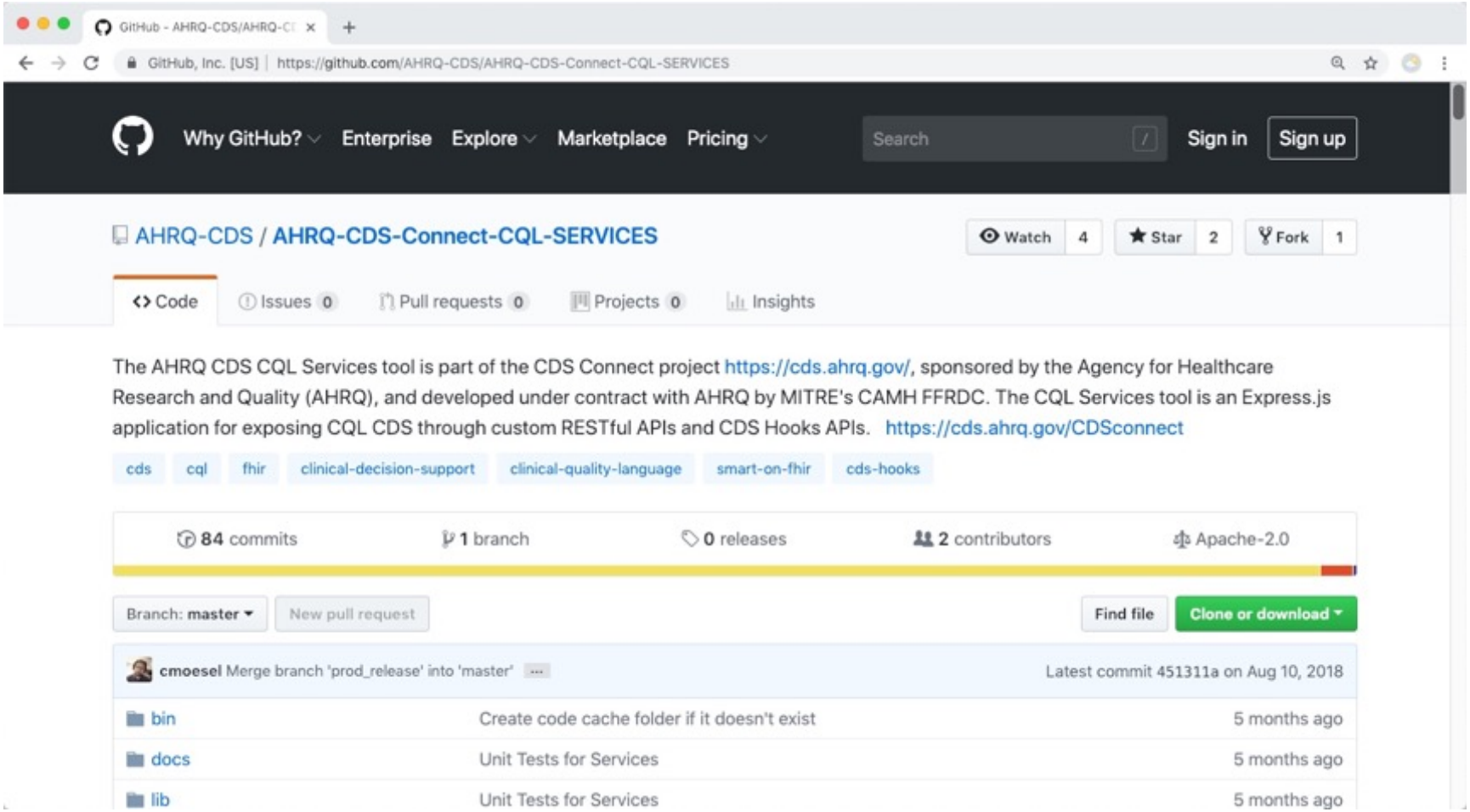


CDS Authoring Tool: Testing

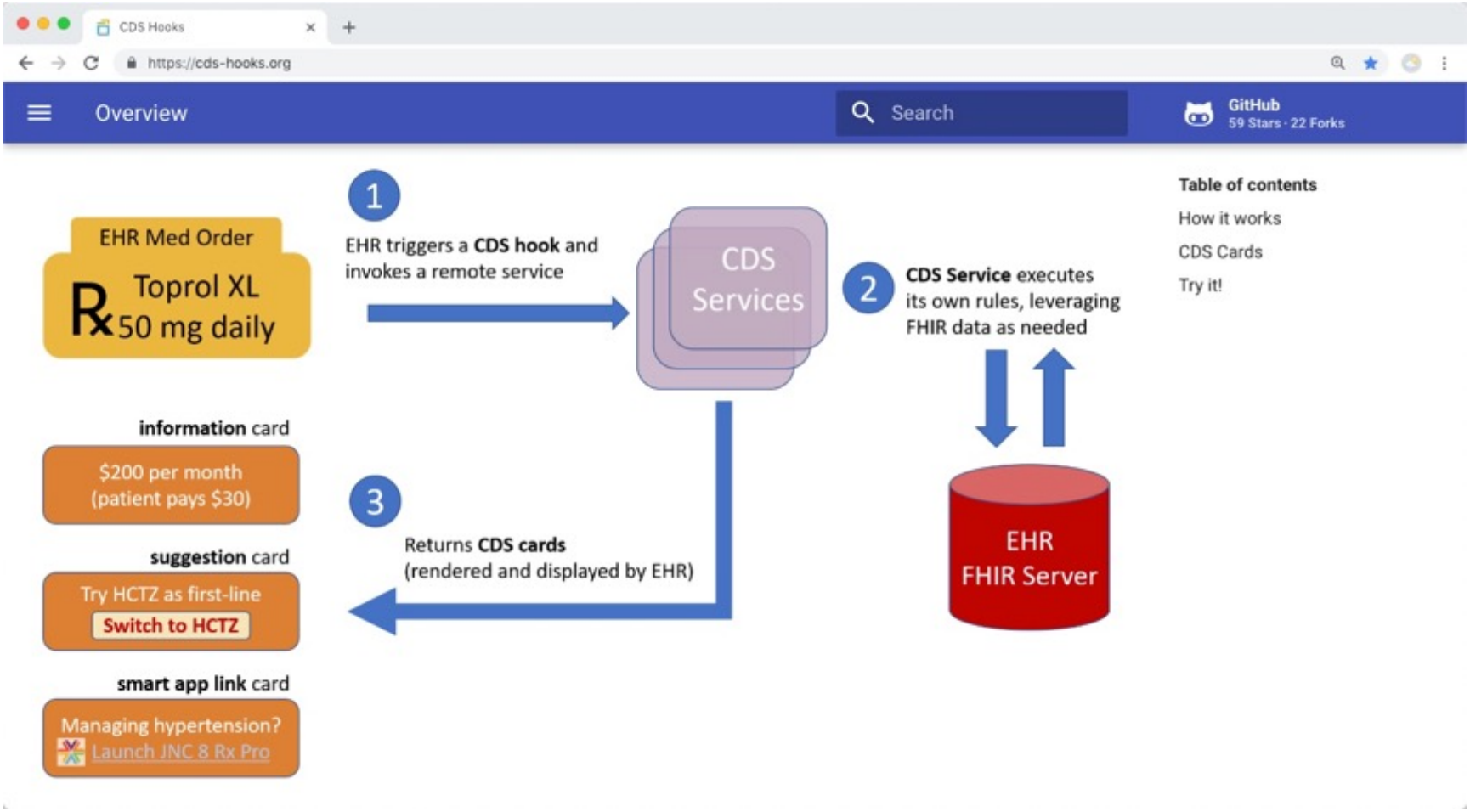


CQL Services

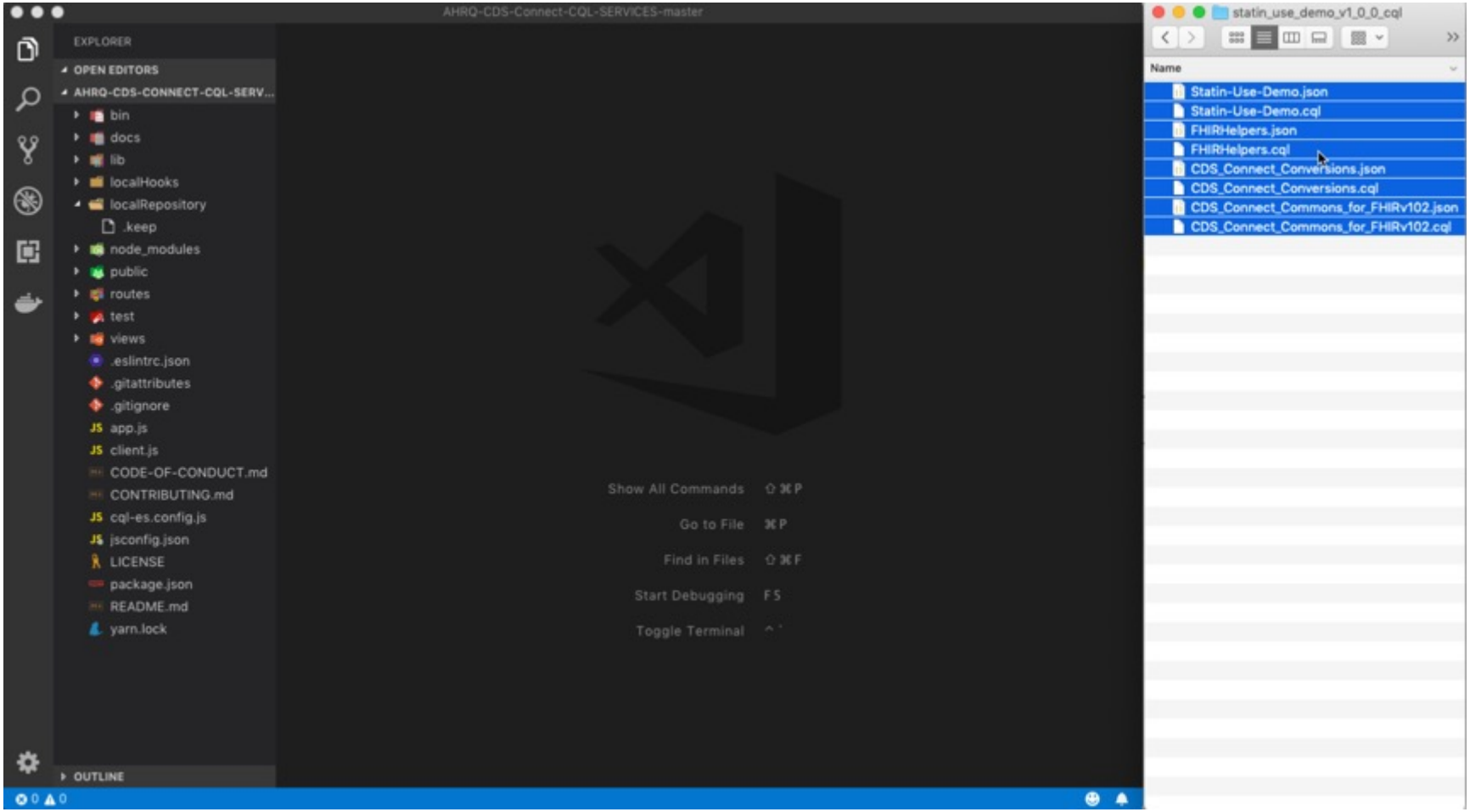
CQL Services



CQL Services: CDS Hooks



CQL Services: Configuration



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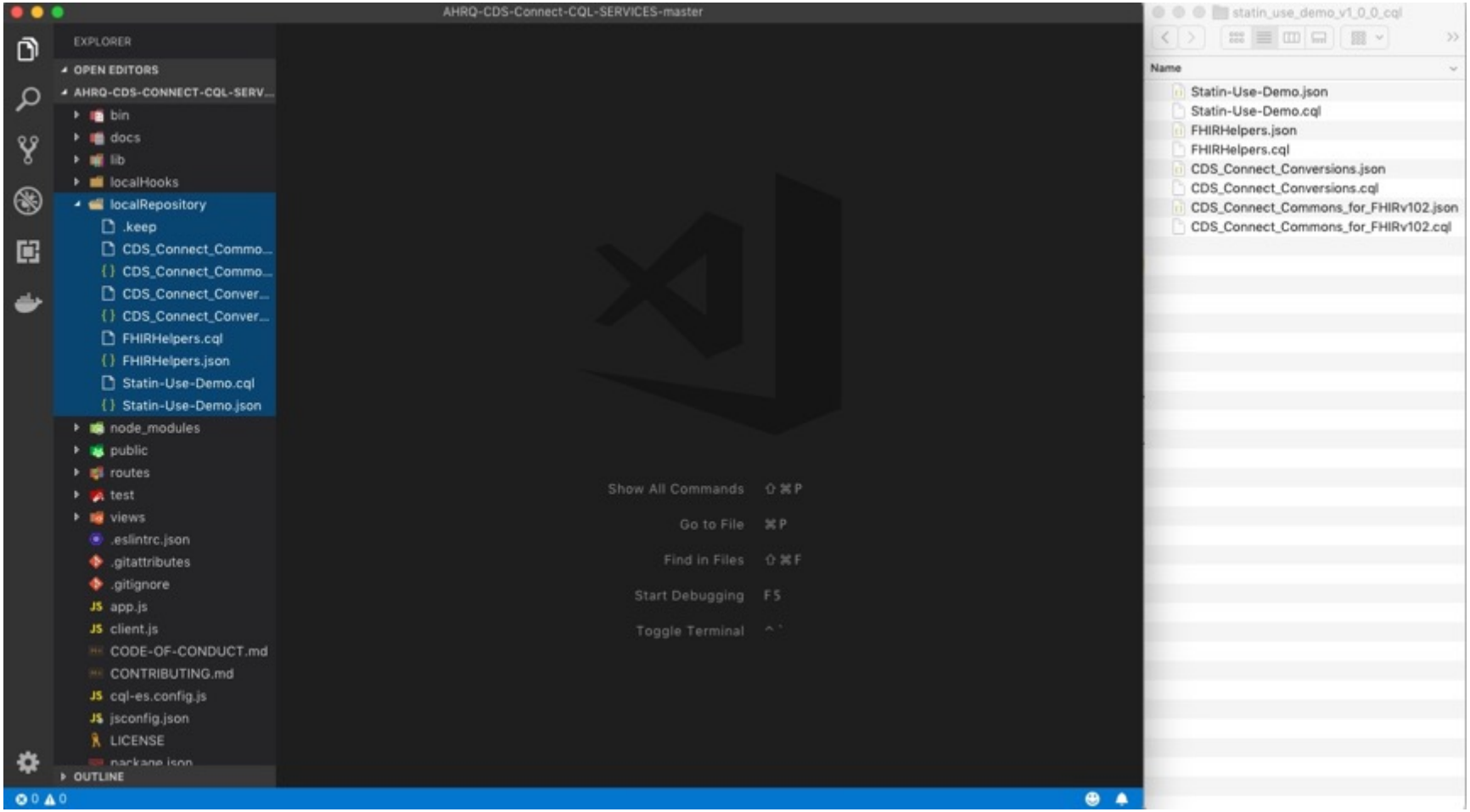

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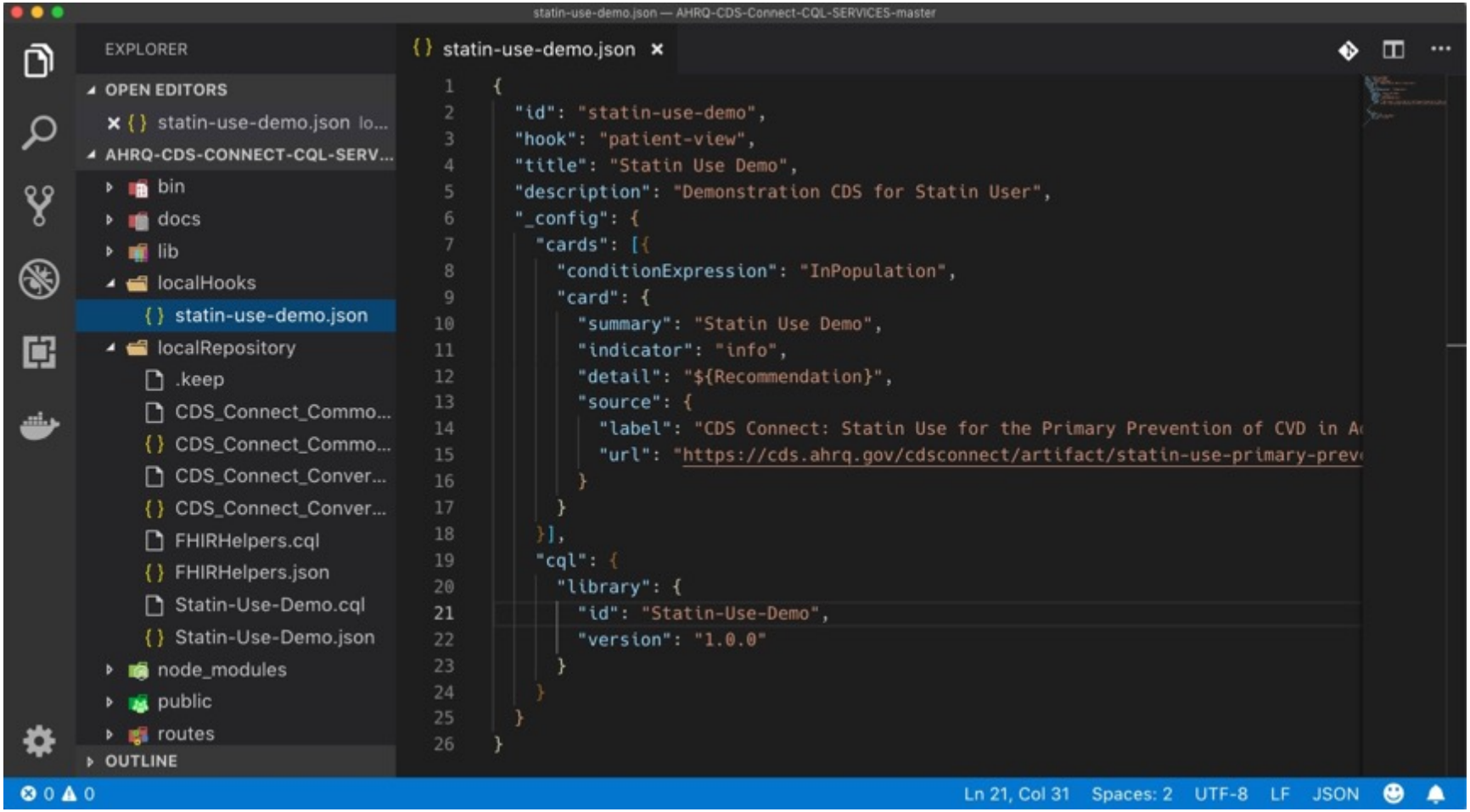
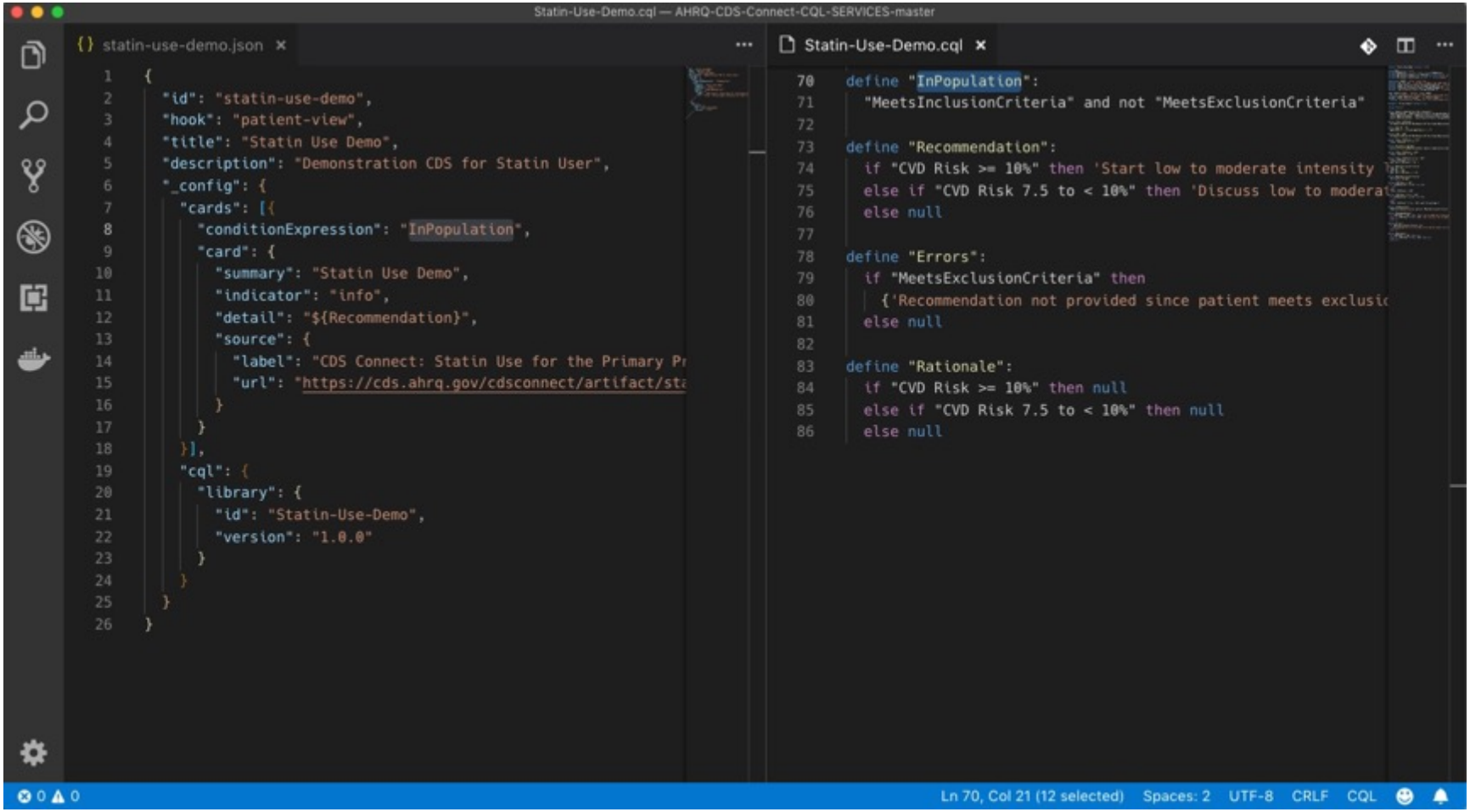
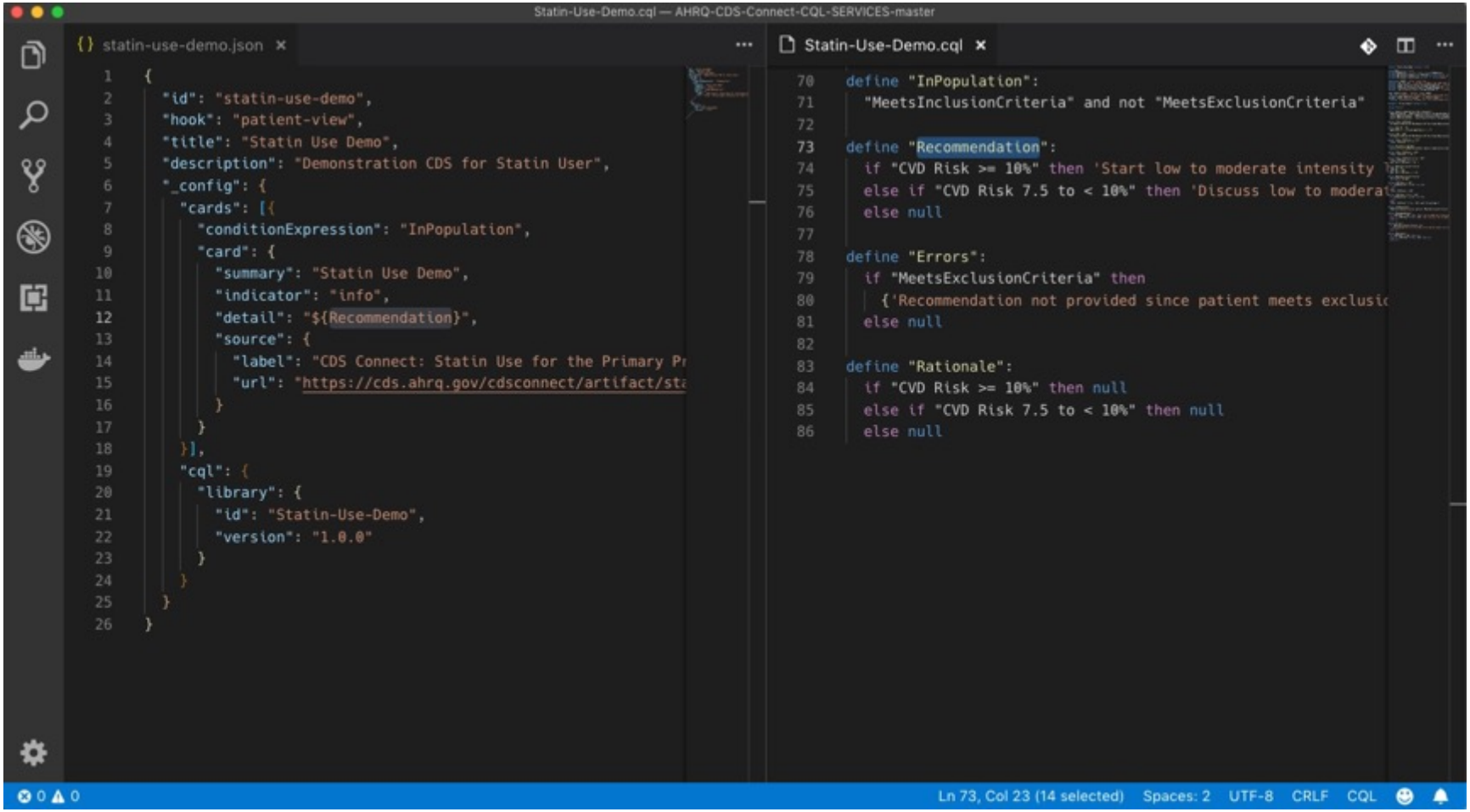


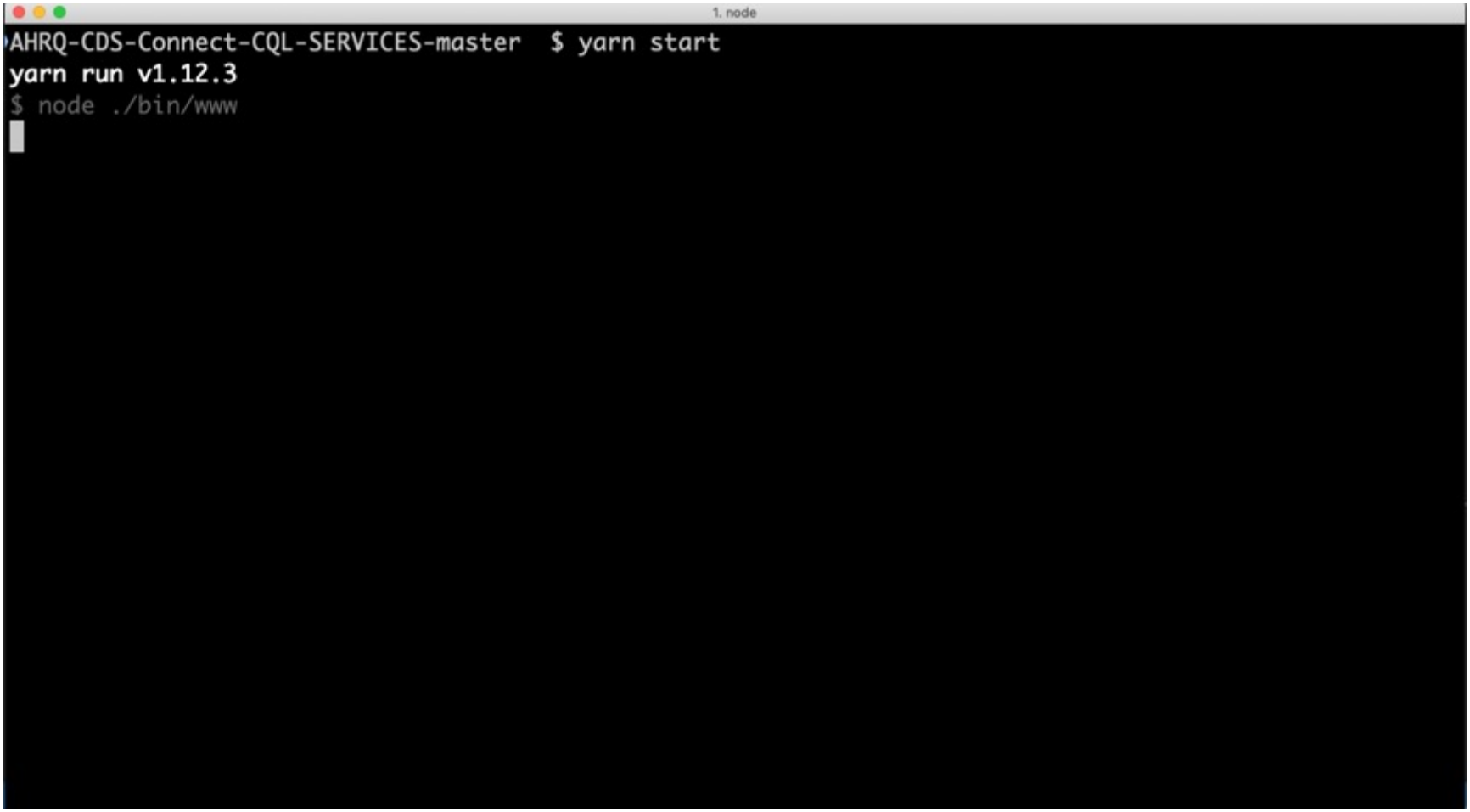
CQL Services: Configuration



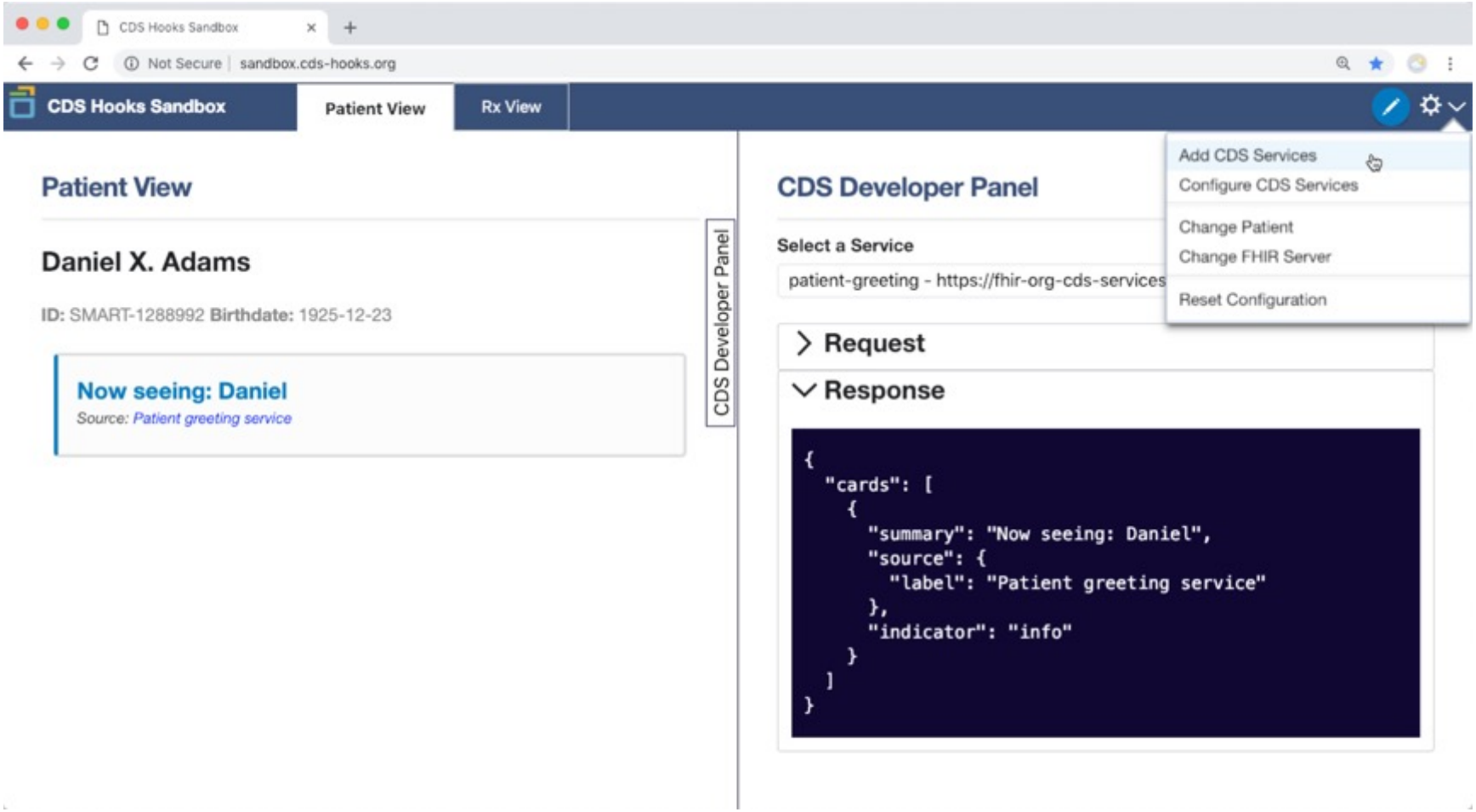
CQL Services: Configuration



CQL Services: Run



CQL Services: CDS Hooks Sandbox



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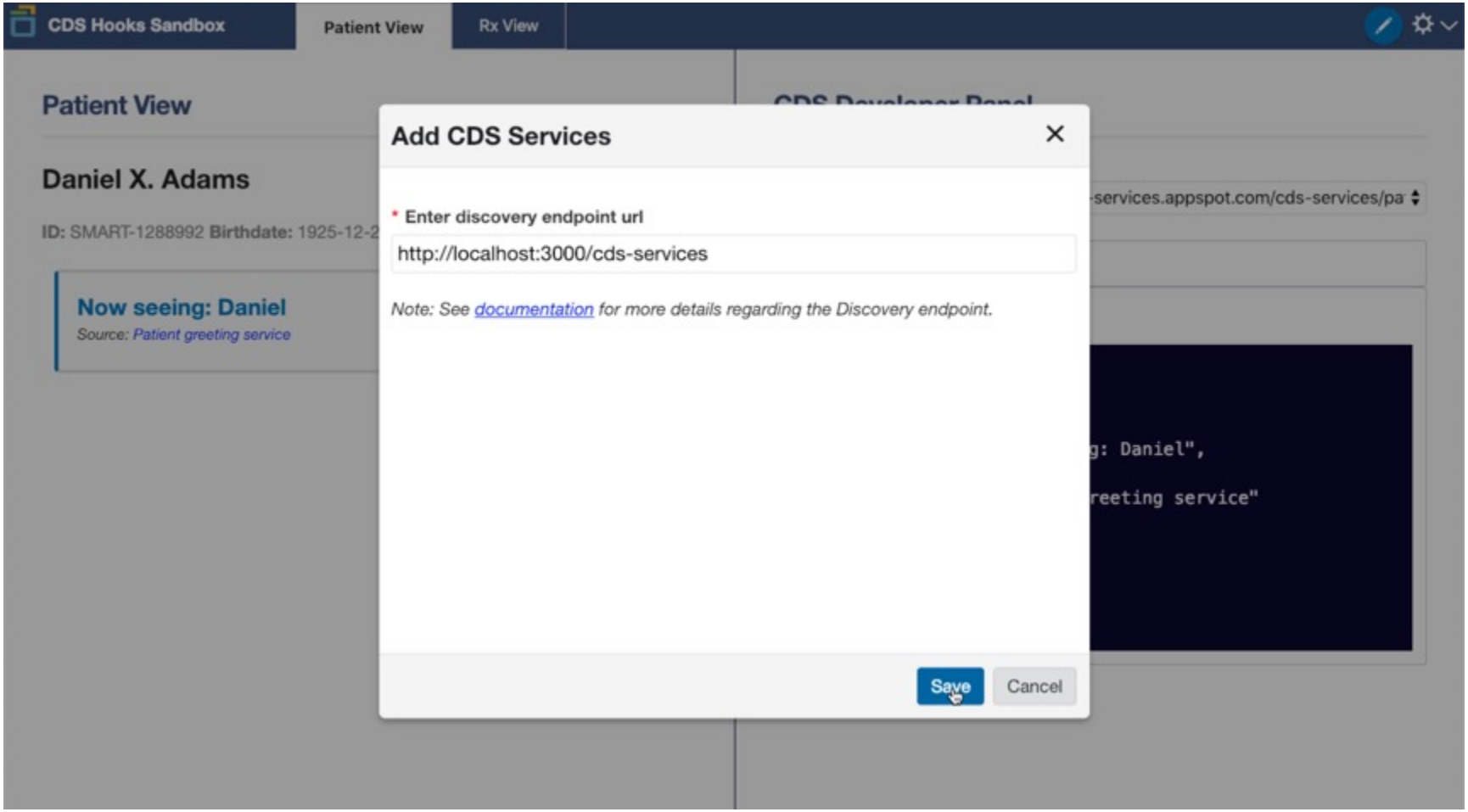

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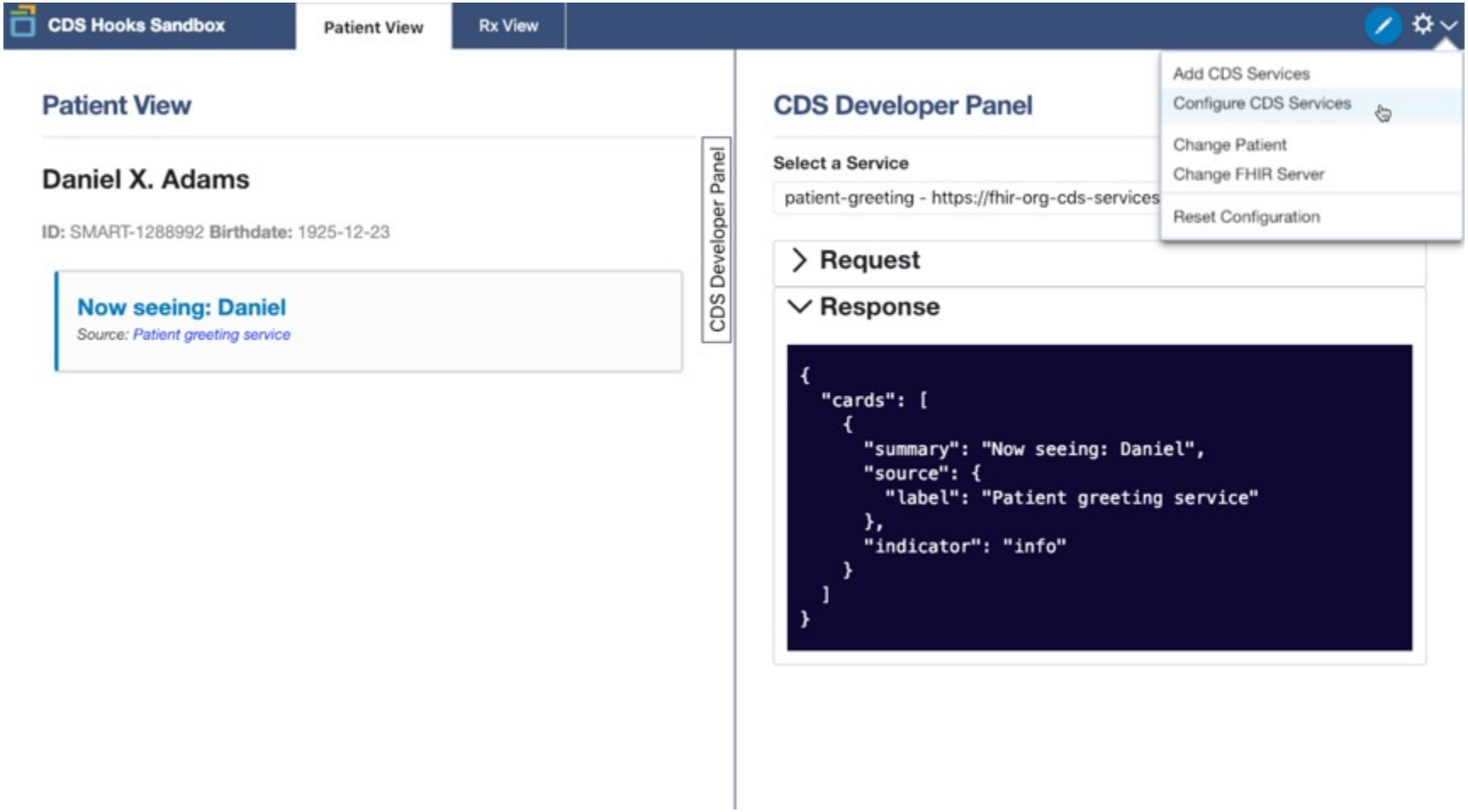
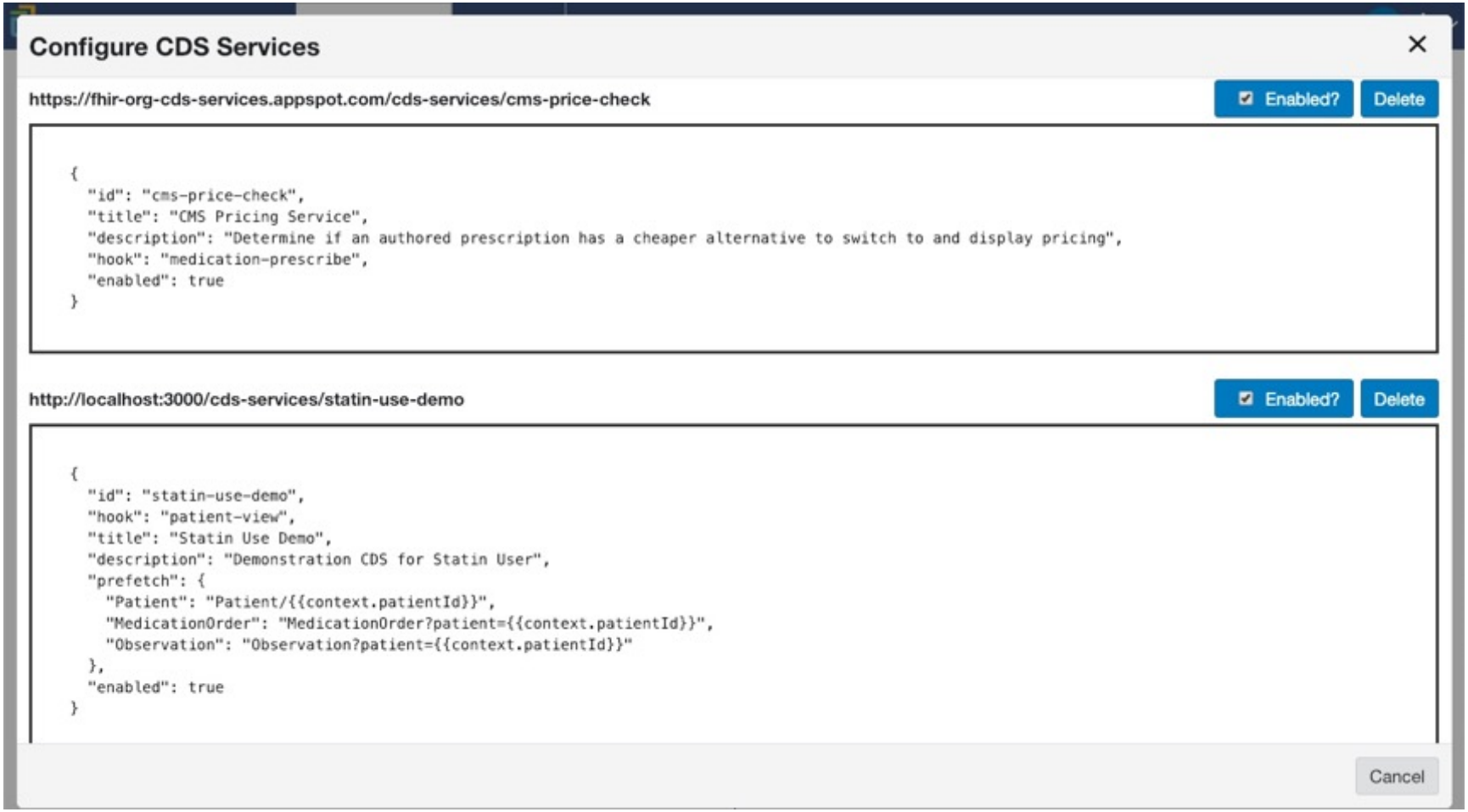


CQL Services: CDS Hooks Sandbox



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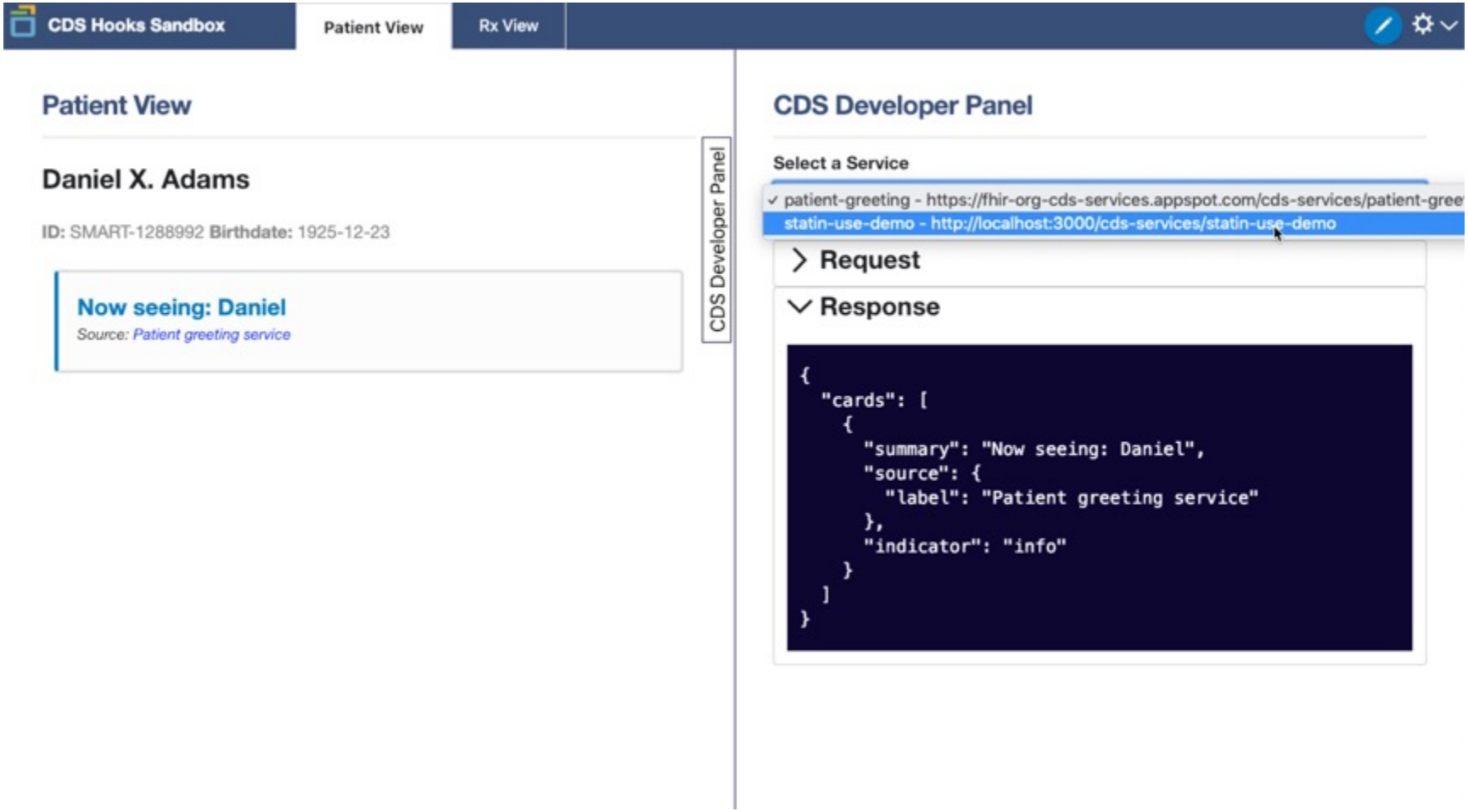

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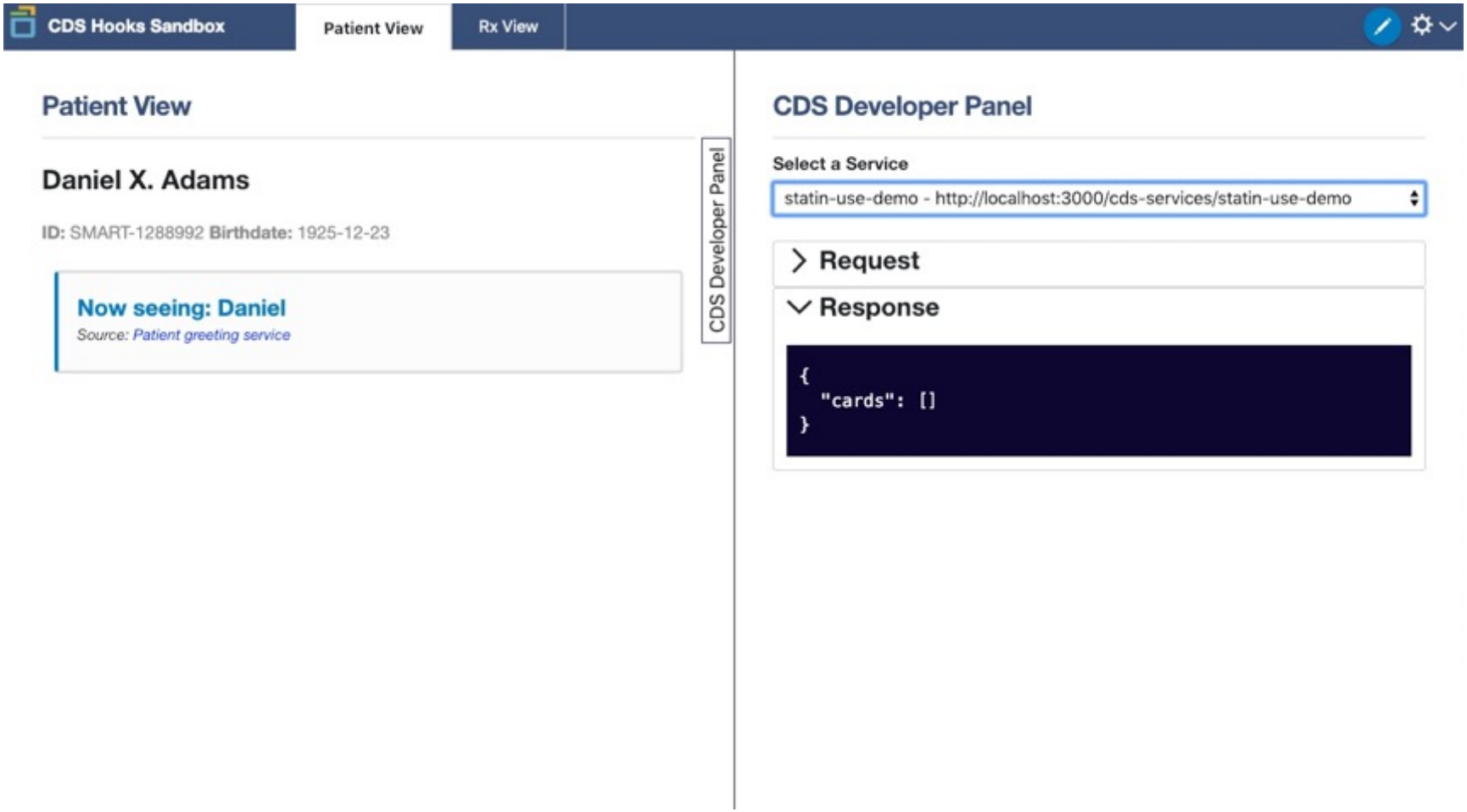

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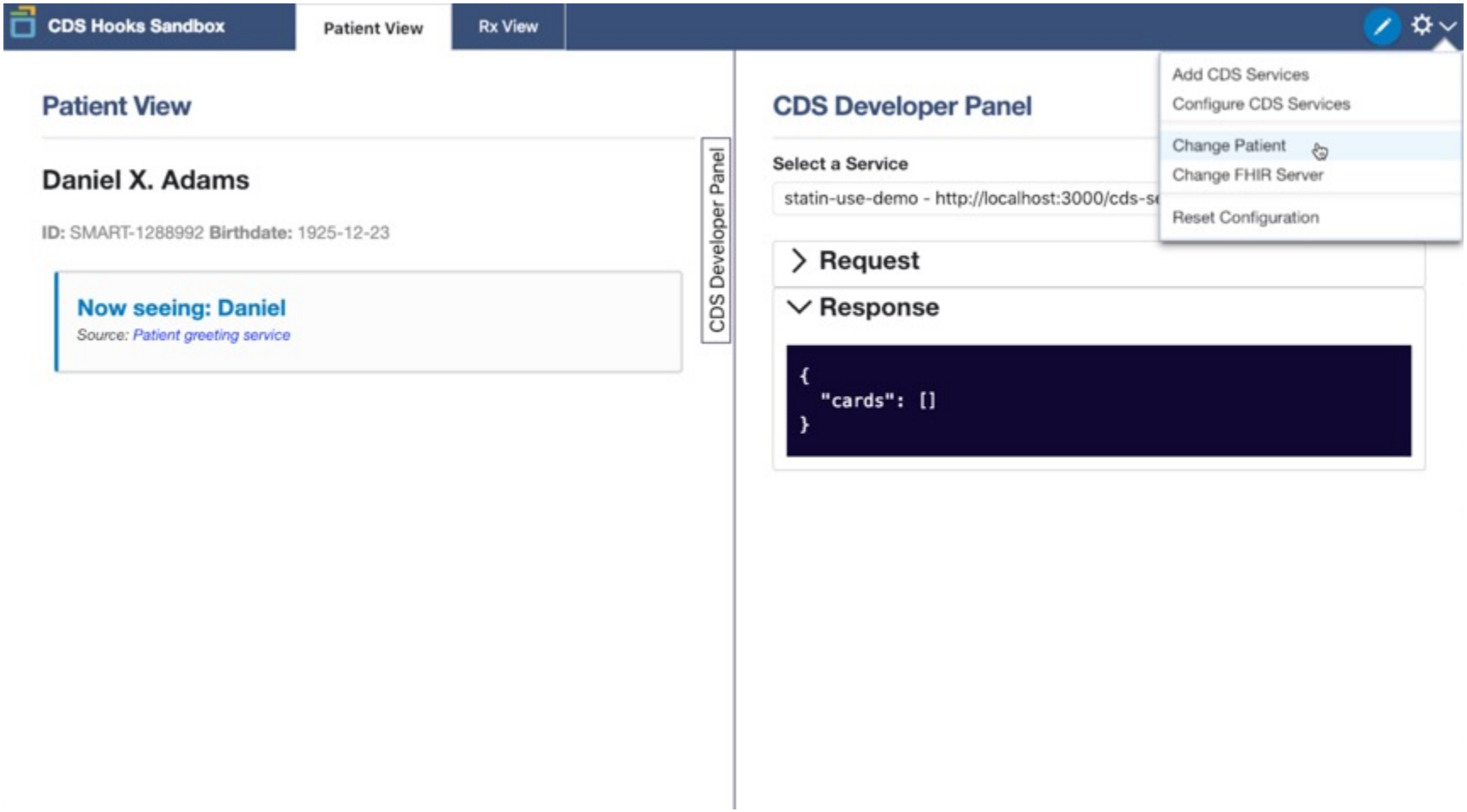

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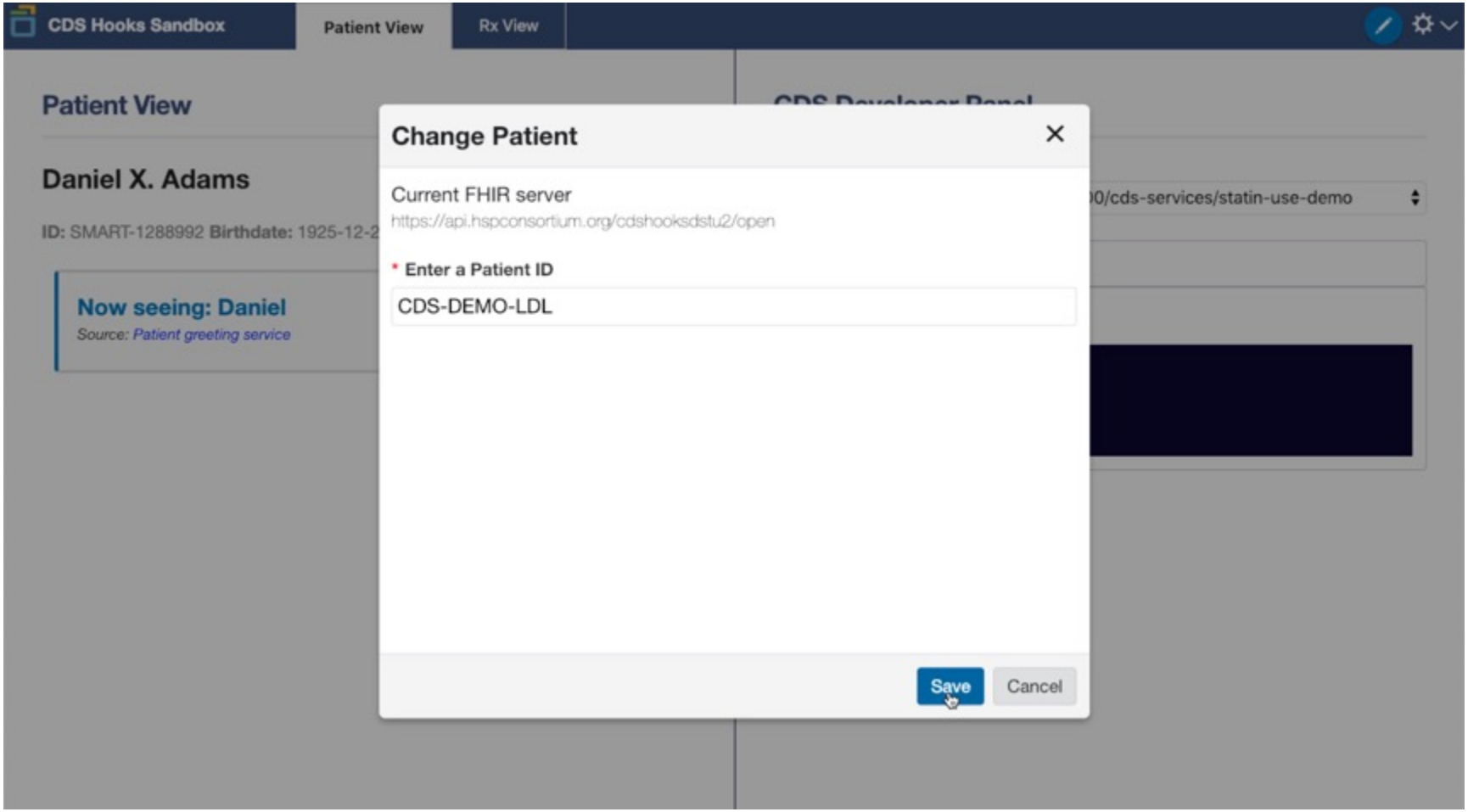
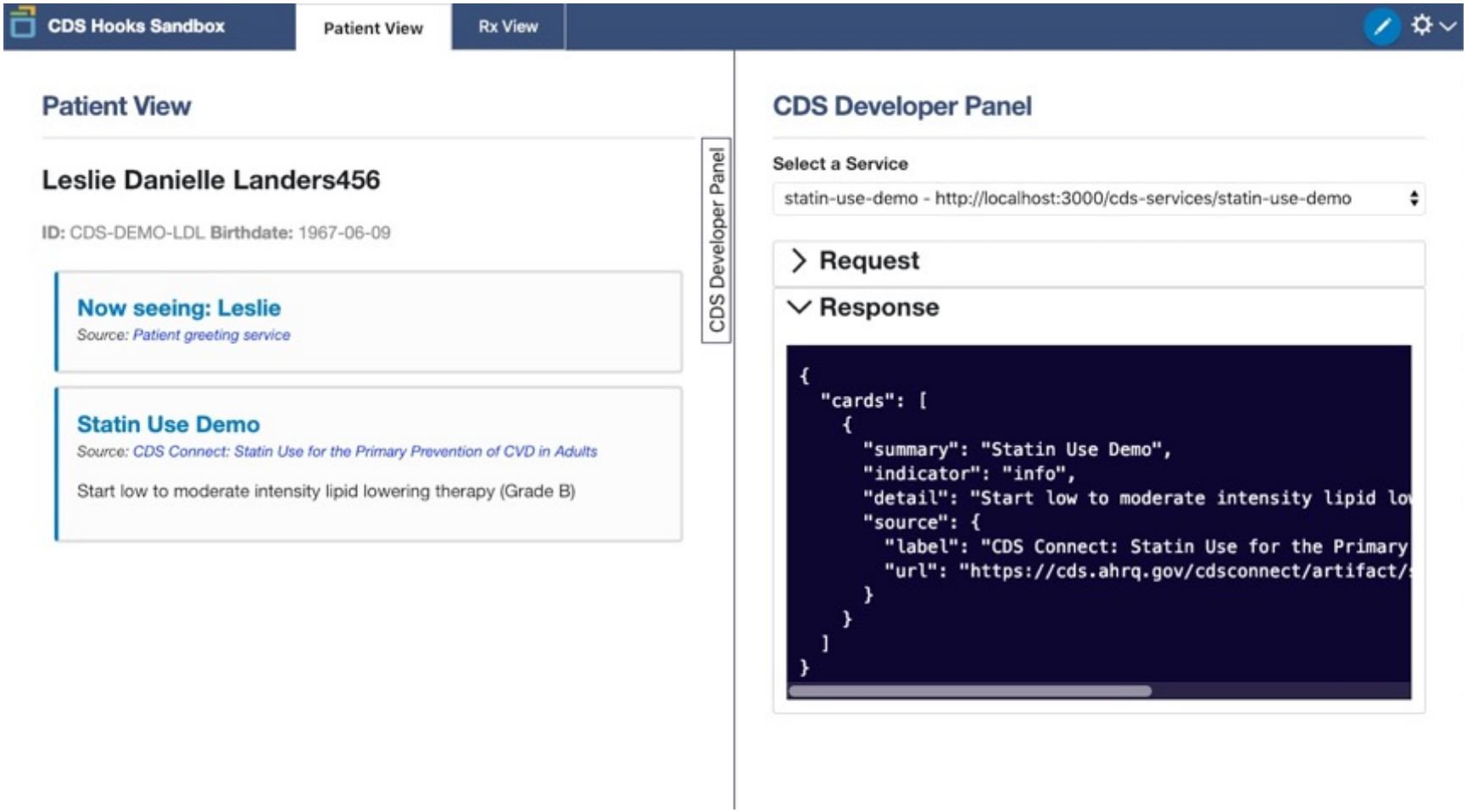


CQL Services: CDS Hooks Sandbox



Contact Info

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  - cmoesel@mitre.org

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Research and Quality

Questions